OPERATING AND SERVICE MANUAL

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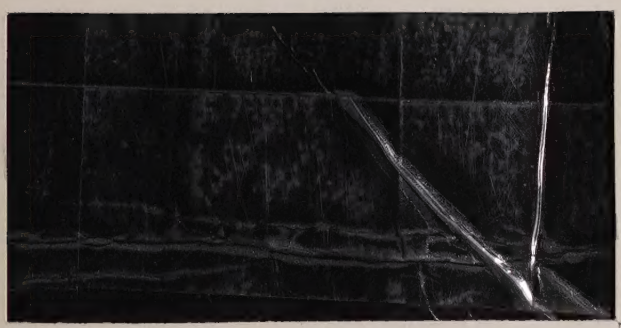

GOULD

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January 15, 1982

K101-D LOGIC ANALYZER

PRELIMINARY

OPERATING MANUAL

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OPERATING MANUAL

K101-D LOGIC ANALYZER

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WARNING

This equipment generates, uses, and can radiate radio frequency energy, and if not installed and used in accordance with the instruction manual, may cause interference to radio communications. As temporarily permitted by regulation, it has not been tested for compliance with the limits for Class A computing devices pursuant to Subpart J of Part 15 of FCC Rules, which are designed to provide reasonable protection against such interference. Operation of this equipment in a residential area is likely to cause interference in which case, the user at his own expense, will be required to take whatever measures may be required to correct the interference.

i. Certification

Gould Inc. certifies that this instrument was thoroughly tested and inspected and found to meet its published specifications when it was shipped from the factory.

ii. Scope

This is a preliminary user's manual for K101-D Logic Analyzers with software Rev. Level A2. Information on the instrument's specifications, general features, and use is included.

No service explanations or communication port information is contained. Please return the attached postcard so that full documentation can be sent to you as soon as it becomes available.

iii. Warranty

All Gould Inc. products are warranted against defects in materials and workmanship. This warranty applies for one year from the date of delivery, or, in the case of certain major components listed in the operating manual, for the specified period. We will repair or replace products that prove to be defective during the warranty period. If a unit fails within thirty days of delivery, Gould Inc. will pay all shipping charges relating to the repair of the unit. Units under warranty, but beyond the thirty day period, should be sent to Gould Inc. prepaid and Gould Inc. will return the unit prepaid. For units out of the one year warranty period, the customer will pay all freight charges.

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Figure 1.1

OPERATING MANUAL

K101-D LOGIC ANALYZER

SECTION I

GENERAL INFORMATION

1.1 Description

The Model K101-D Logic Analyzer is a high performance, general purpose digital test instrument designed to offer users powerful capabilities to examine real time execution of program flows, system timing characteristics, and the interaction of these elements; hardware/software integration and verification. Applications include hardware and firmware design and debug, ATE, field service, and education areas.

The unit has 48 data inputs feeding a pipeline of three high speed registers, each 52 bits wide (48 data bits plus 4 trace level tracking bits). Data from the pipeline registers is next transferred to the actual trace memory "M", which is 512 words of 52 bits each. The storage of each word in the "M" memory is determined independently based on current Selective Trace Control specifications. This feature provides data capture with unprecedented versatility and precision for rapid isolation of essential information.

When a trace is completed, data is transferred from the M memory to the display memory A. Memories A and B, respectively, hold the last recording made and a previously stored reference recording. Data stored in these memories can be reviewed in various formats using either the Data, Graph, or Timing displays.

Input sampling is performed using either external, internal, or mixed clocking. Twelve separate external clocks (6 sample clocks and 6 latch enables) combine using menu driven boolean equations for flexible software monitoring. A number of different internal sampling rates allow precise selection of the desired timing resolution for determining signal pulse widths and skew measurements. Mixed clocking allows both external and internal sampling to be done simultaneously. Separate clocks may be defined for each of three sections of 16 data inputs (C,B,and A) or a single Master clock may be used to sample all three sections at the same time.

User interface to the instrument is primarily based on the concept of a screen oriented database editor. Each of the major modules regarding all trace parameters, data formatting, analysis, and communications is called by pressing one of the "Specify" keys, such as "Logic Polarity". When a key is pressed, the appropriate firmware module is called and the current specifications for that module are displayed on one or more CRT screen pages. This allows rapid review and modification of each module. Changes to a screen menu are made by

positioning a blinking cursor over the pertinent field and entering the new specification using either the Choice keys or direct entry.

Additional measurement capabilities built into the K101-D include a real time TOD clock, a 3 1/2 digit DVM, and an external frequency counter. These measurements facilitate analysis of recordings, increase convenience of use, and minimize reliance on other measurement systems.

Completely automatic control of the instrument can be achieved using either of two fully programmable communications ports; IEEE-488/1978 or RS-232-C I/O interfaces. Simple key codes and data transfer formats allow the unit to be controlled remotely using many common desktop computers and terminals. Generation of hard copy, data logging, storage of common trace specifications, and automatic capture of intermittent system failures can all be facilitated by utilizing these interfaces. A third interface, an RS-449 port, is also included to give the K101-D the ability to communicate with intelligent peripherals and probing accessories.

Confidence in the unit's operation is ensured by three separate diagnostic tests; a comprehensive "Power-Up" test, a "Probe Test" that provides a functional check on each probe (10 inputs at a time), and, when maximum confidence is desired, an exhaustive series of specialized tests can be chosen using the "Self Test" specification screen. These tests virtually ensure proper operation. If a problem does occur, the tests are designed to quickly find and isolate it. Downtime is minimized and suspicious recordings can be easily checked.

1.2 SPECIFICATIONS

SIGNAL INPUTS

Number: Total of 60; 48 data inputs and 12 clock inputs.

Input Sections: Three; labeled C, B, and A. Each section contains two groups of 10 inputs each; 16 data inputs and 4 clock inputs.

Input Impedance: 1 MΩ, 15 pF, over a range of ±10 V.

Thresholds: Assignable for each group of 10 inputs; TTL(+1.40 V), ECL(-1.30 V), VAR A, VAR B(±9.98 V in 10 mV steps with 20 mV accuracy). Thresholds referenced to probe tip.

Polarity: Assignable positive or negative for each data input.

Maximum voltage: ±50 V continuous, ±100 V transient.

Input Modes: Selectable in groups of 8 or 16.

Sample: Threshold level detected at active clock edge for all inputs simultaneously.

Glitch: Detects one or more transitions between two successive clock intervals. Stored in one or two memory cells. Minimum detectable glitch: 5 ns pulse width at threshold with 25% peak threshold overdrive.

Latch: When Enable Clock goes FALSE, data is held. When Enable Clock goes TRUE, data is taken into latch registers. Data is clocked into sample registers by a combination of sample clocks.

Demultiplex: First eight data inputs of an input section are automatically applied to the second group of eight data inputs. First group is assigned to Sample mode and second group to Latch. All 16 channels strobed into main memory simultaneously. Eliminates double probing of multiplexed nodes.

CLOCKING SELECTION

In external and mixed clock modes, the K101-D allows external AND/OR clocking of Sample and Enable Clocks for each data input section. A Master Sample Clock strobes data from the high speed inputs into the unit's main memory (M). Complex external clocking is selectable using menu-driven sets of Boolean expressions. Monitoring of multi-phased and multiplexed systems, as well as simultaneous time/data measurements, can be accomplished.

In internal and mixed clock modes, the K101-D loads data from internally clocked sections at the internal rate specified for that section.

Sample Clocks

Inputs: Total of six (one per input pod). DC to 50 MHz external operation. Minimum pulse width: 10 ns.

Operation: Sample clock active on positive edge. Clock is TRUE when all three AND clocks are TRUE or when any OR clock is TRUE.

AND Clocks: Total of three (CJ, BJ, AJ). User-specified polarity.

OR Clocks: Total of three (CK, BK, AK). User-specified polarity.

Enable Clocks:

Inputs: Total of six (one per input pod). DC to 50 MHz external operation. Minimum pulse width: 8 ns.

Operation: Enable Clock used when data from a section (C, B, or A) is placed in Latch mode. When Enable Clock is TRUE, data passes through input latches. When Enable Clock is FALSE, data is held in the input latches. Enable Clock is TRUE when all three AND clocks are TRUE, or when any OR clock is TRUE.

AND Enables: Total of three (CR, BR, AR). User-specified polarity.

OR Enables: Total of three (CS, BS, AS). User-specified polarity.

Clock Modes:

Internal: 20 ns to 160 ms. Selectable in a 1 through 16 sequence. All sample registers and control logic clocked simultaneously by Internal Clock.

External Single-Phased: DC to 50 MHz. All sample registers and control logic are clocked by the Master Clock.

External Multi-Phased: User may specify a separate Sample Clock for each section and for the Master Clock. All three sections transfer data into main memory M using the Master Clock.

Mixed Single-Phased: Master Clock must be external. Sample Clocks may be internal or external. External Sample Clocks must be same as Master. Internally clocked sections transfer data to main memory M using the Internal Clock.

Mixed Multi-Phased: Master clock must be external. Sample clocks may be internal or external. External Sample clocks are specifiable separate from Master Clock but data still transfers into main memory M using the Master Clock. Internally clocked sections transfer data to main memory M using the Internal Clock.

Internal Extended: Provides 10 ns data sampling and transfer to main memory M for one or more input sections. Control logic and other input sections are clocked using the slower Internal Clock (20 ns to 160 ms).

TRACE MEMORY

The K101-D contains high speed main memory M, storage memory A, and reference memory B.

Size: M, A and B are each 52 bits wide by 515 bits long; 48 bits wide for data inputs plus 4 bits for Trace Level Tracking by 512 bits long plus 3 bits for pipeline data. 48 by 512 bits of M are under Trace Control.

Operation: M accepts new data and transfers it to Memory A for display. Memory B is used as a reference and may be loaded from A, the keyboard, GPIB, or RS-232-C interfaces.

Search: Unit accepts up to a 48 bit pattern through the Data Format display. Search for pattern occurs in both A and B memories. Occurrences are marked by asterisks (*) on Data displays. First and last memory locations identified on display, along with total occurrences. Also, pressing "Next" key moves Cursor from current position to first true occurrence following next false occurrence each time key is pressed.

Compare: Memory A compared to Memory B. Differences indicated by "≠" signs on data displays. "Next" key works as in Search mode above.

Edit Mode: User may enter or edit data in memory B using keyboard entry.

DATA FORMATS

User defines data display characters. Multiple menu screens allow selection of both radix and data inputs for each character (max of 48). Binary, Octal, Hex, ASCII, and EBCDIC available in mixed formats plus fixed Binary, Octal, and Hex formats. Device specific data formats for disassembly available using optional accessories.

TRACE CONTROL

Provides selective Trace Control of memory contents using up to sixteen separately specifiable levels. Allows precise definition of data to be captured and facilitates very efficient use of memory space. Each level offers individual Delay plus conditional Stop, Jump, Advance, and Trace commands.

Delay: Entered as Decimal or Hex. Range = 1 to 65,535 (1 to FFFF Hex). Sample Count for Delay specifiable using either occurrences of the Master Clock or of the level's Advance Pattern. Sample Count is re-initialized by each level entry.

Stop: Provides nine different commands to Stop tracing immediately; Stop If Data = S; Stop Always; Stop Never; and Stop If Data = S And Sample Count >, <, =, ≥, ≤, or ≠ Delay. "S" may be any non-contradictory data pattern possible given the current arrangement of the Data Format screen. All variations of each specified character can be entered including a "Don't Care" state. Stop has priority over Jump and Advance commands.

Jump: Trace control jumps immediately to user defined level (0-F) if specified conditional command comes true. Same nine types of commands available as for Stop except that "Jump" replaces "Stop" and "J" replaces "S". Can be used as either partial or total sequence restart or to follow alternate data path. Jump has priority over Advance command.

Advance: Trace control advances immediately to next level if specified conditional command comes true. Same nine types of commands available as for Stop except that "Advance" replaces "Stop" and "A" replaces "S".

Trace: Provides Selective Trace recording of each valid data sample based on whether or not that sample meets specified trace conditions. Conditions include same nine types of commands used for Stop except that "Trace" replaces "Stop" and "T" replaces "S".

ARM MODES

Selectable as Manual, Auto, Auto Stop, or Auto Stop Within Limits.

Manual: User presses Arm key and unit makes one recording and transfers new data to Memory A.

Auto: User presses Arm key and unit makes recording then continues to re-arm itself; each time transferring new data to Memory A. Pressing Stop key or reaching Pass Counter limit halts new acquisitions. Pass Counter range = 1 to 9,999 cycles.

Auto Stop: Unit arms itself and acquires new data in Memory A, which is compared with Memory B. Conditions that stop the unit from re-arming and recording further are: A=B, A≠B, or Pass Counter reaching specified limit.

Auto Stop Within Limits: Comparison of A and B limited to data between the unit's dual cursors inclusively as specified in Memory A. Also, only displayed data channels are compared. Conditions that stop the unit from re-arming and recording further are: A=B Within Limits, A≠B Within Limits, or Pass Counter reaching specified limit.

Acquisition Command Keys

Arm: Initializes control logic for all currently specified recording parameters and begins new recording using current Arm Mode, even if unit was already armed.

Advance: Causes unit to advance to next Trace Level.

M to A: Moves current contents of Trace Memory M to Display Memory A and stops recording cycle.

Stop: Stops recording cycle and leaves contents of Memory A intact.

DISPLAYS

The K101-D employs a built-in 7" diagonal raster scan CRT for display of all menus and data. Three main types of displays are generated; the menu screens for recording specification, data displays for recording analysis, and a screen for entering Interface specifications.

Recording Specification Screens

Input Modes: User selects input modes in 8 channel input groupings (Sample, Glitch, Latch, and Demux). Thresholds and ARM condition also selected on this display.

Logic Polarity: + or -, assignable by user to each data input. Affects Data display and Trace Control patterns only.

Clock Select: User specifies clock mode and clock input selections using one of six menus.

Data Format: User defines data display radices (Octal, Hex, Decimal, Binary, Sign, ASCII, or EBCDIC) for 48 inputs. Inputs may be in any sequence and may be repeated. **Trace Control:** User defines trace control parameters for 1 to 16 levels.

Recording Analysis Displays

Data: Presents data to 48 columns wide as determined by Data Format Specification display. When less than 24 columns are specified, format is repeated to provide more data on the display (24, 48, 72 or 96 samples).

Timing: Simultaneous display of up to 24 timing waveforms. A total of up to 60 waveforms may be displayed by paging (6 signal per page x 10 pages). Seven character user selected labels can be entered as desired for each waveform using keyboard. User specifies channel sequence for display. Vertical expansions of 6, 12, and 24 provided. Horizontal expansios of X1, X3, X6, and X12 provided. Display indicates sample count between Cursor and Reference. Binary logic readout of Cursor or Reference position.

Graph: Provides dotted graph of data value versus sample number (x, y). User selects data inputs and range of values graphed. Reference and Cursor provide same operation as in Timing display. Horizontal expansion same as Timing. Graph mode gives user a quick overview of program execution.

Interface Specification Screen:

User selects GPIB (IEEE-488) and RS-232-C interface parameters. TOD clock ,date, and error beep status also entered. Software revision level displayed.

AUXILIARY MEASUREMENTS

Digital Voltmeter (DVM)

Front panel IN and GND provide ±20 V range.

Resolution: 20 mV.

Accuracy: ±0.5%

Input Impedance: 20 KΩ

Clock Status/Frequency

Automatic measurement of external clock frequency.

Range: 100 Hz to 50 MHz.

Accuracy: 0.1%.

Time of Day

24 hour TOD clock displayed in all modes. End of Aquisition time captured for each recording. Time retained by battery when power is OFF.

Total Trace Time

Displays total time trace was enabled for each recording at bottom of Timing display. Allows precise measurement of time between any two events.

Trace Level Tracking

Allows user to determine Trace Level reached during recording and to determine level used to record each sample when reviewing recording.

Trace Level: Shows user current or last level reached during recording. Shown at bottom-right of all displays as "Level = ".

Cursor Level: Shows user which level was used to record each sample. Shown just to left of Trace Level field as "CL= ".

INTERFACES/REAR PANEL CONNECTORS

GPIB (IEEE-488/1978): Provides complete programmability via GPIB. Data transferrable to and from either A or B memories.

RS-232-C: Same capabilities as GPIB.

RS-449: Allows unit to communicate with intelligent accessories.

Trace Output: TTL active high while unit armed and tracing. Synchronous with master clock.

Clock Output: ECL active low signal corresponding to current Internal Master Clock rate.

GET: Group Execute Trigger signal. Available via GPIB.

Video Output: 1 V p-p into 75Ω RS-170 compatible levels.

CONFIDENCE TESTS

Power-Up: During power-up K101-D performs check of ROM, MPU and CMOS RAMs, , power supplies, and keyboard. Gives user confidence that instrument is operating properly.

Self Test: Allows user to select from a series of additional test routines to serve as a troubleshooting aid.

Probe Test: Allows user to test each probe (10 inputs at a time) with a built-in ring counter type pattern generator.

ACCESSORIES SUPPLIED

Probes: Set of six input probes with 10 inputs each. Probes include flying leads and spring hook tips.

Manual: One operating and service manual supplied with each K101-D.

MISCELLANEOUS

SIZE: 21.8 cm high x 44.6 cm wide x 59.0 cm deep with bail (8.6" x 17.5" x 20.7").

Weight: 20 kg with probes (44 lbs.)

Power: 90-132 V RMS; 400 Watts.

200-268 V RMS; 400 Watts.

Temperature: 0 to 50°C operating range.

Battery Back-Up: Provides power for two Set-Up Saves plus TOD clock.

Accessory Power: +5 V and -5.2 V, 300 mA total. Located at two rear panel LEMO connectors.

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K101-D LOGIC ANALYZER

SECTION II

USER ORIENTATION

2.1 Input Power Requirements

2.1.1 Input Voltage Selection

Input voltage selection is made inside the K101-D.

All units are shipped from the factory set to operate at 115 VAC line input.

To change the input voltage selection switch from 115 to 230 VAC do the following:

1. Remove the top cover.
2. Locate the input voltage selection switch in the rear quarter area, left hand side of the instrument when reviewed from the front.
3. Move the input voltage switch to the desired range, 115 VAC or 230 VAC.

	FUSE
115 VAC	7 AMPS
230 VAC	4 AMPS

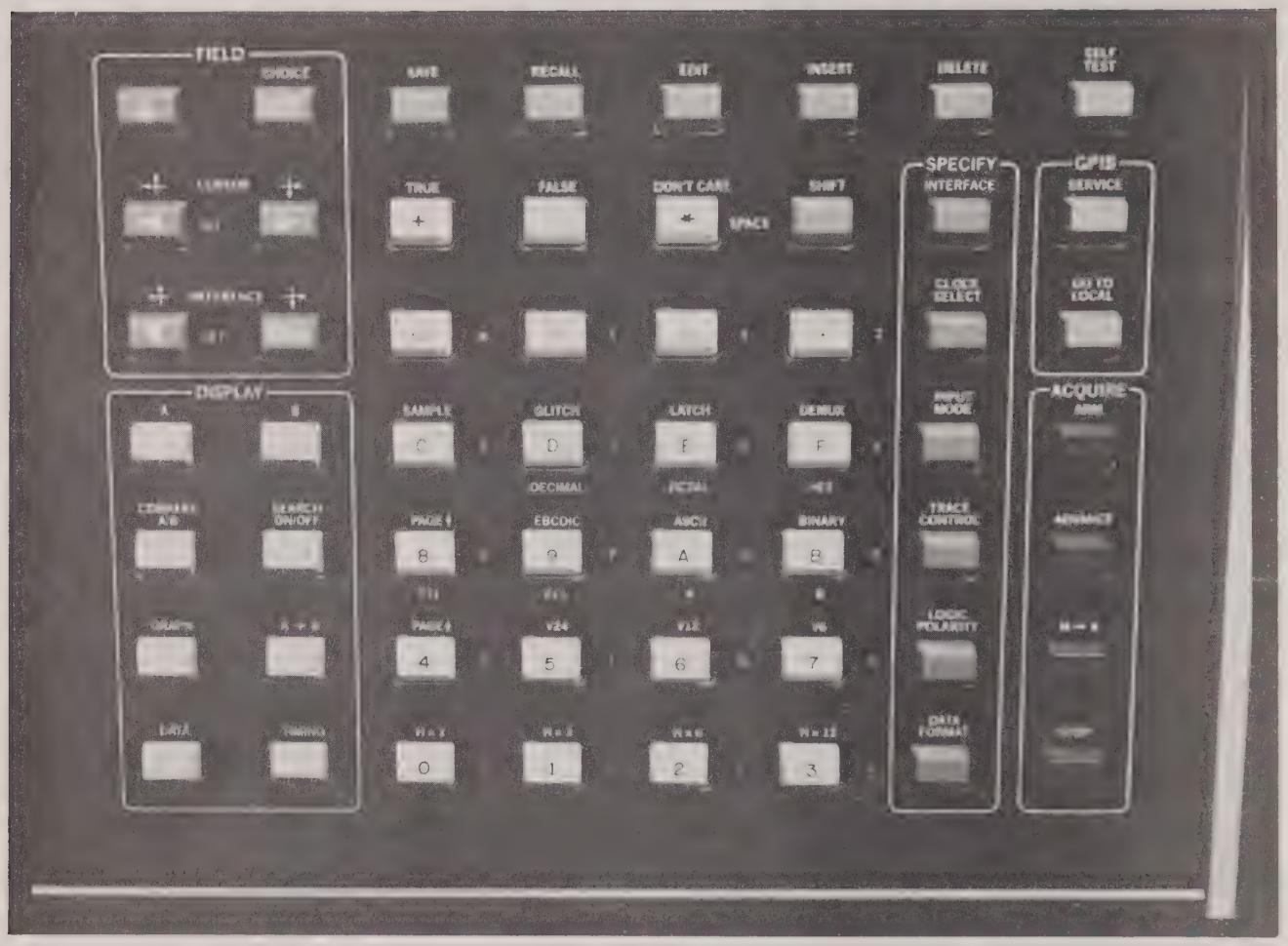

Figure 2.1 K101 Front Panel

2.2 Keyboard General Description

The keyboard of the K101-D has been divided into the following areas:

SPECIFY

FIELD

DISPLAY

GPIB

ACQUIRE

GENERAL

Specify Keys

All display menus are selected using these 6 keys. The display menu title is located at the top of each display under the GPIB information.

Field Keys

The field area contains the K1010-D data and parameter selection cursors. Most K101-D entry fields can be programmed by using these keys to step through the display parameters which will blink when selected. Parameters can be changed using the "NEXT", "CHOICE", and "PREV" keys.

Display Keys

These keys select the DATA, TIMING, or GRAPH displays as well as "A MEMORY", "B MEMORY", COMPARE, SEARCH, and A-B functions.

GPIB Keys

These keys perform the front panel GPIB functions. The GPIB status is shown at the top of each K101-D display.

Acquire Keys

ARM actually starts a recording, ADVANCE will cause the unit to manually jump to next trace control level, M-A transfers high speed memory to display memory, and STOP will halt the K101-D during recording cycles.

General Keys

All miscellaneous direct entry key functions fall into these categories.

1. The "SAVE" and "RECALL" keys in the top row of keys are used for storing and retrieving a user select menu set-up; recalling the power down menu states using the shift and recall keys.

2. The ASCII keyboard and the yellow letters round out the ASCII character set when using the shift key, and are used for labeling channels in the timing display.

3. The SELF TEST key resets the K101-D and performs a menu oriented diagnostic check.

2.3 Keyboard Detailed Description

2.3.1 Display Key Selection.

Press "A"

This key allows the user to examine the contents of the display memory.

Press "B"

This key allows the user to examine the contents of the reference memory.

The "EDIT" key may be used to alter the contents of B MEMORY.

Press "COMPARE A/B"

This key allows the user to automatically compare the contents of A and B memory.

Example: Comparison results will appear at the bottom of the CRT with results such as:

Total ≠ = 20 First ≠ = Ø Last ≠ = 450

Press "SEARCH ON/OFF"

The user must first enter the data format (specify section) and enter the word to be searched for.

1. Once the search word is entered a search can then be conducted.

Example: Comparison results will appear at the bottom of the CRT with results such as:

Total * = 1 First * = 350 Last * = 350

Press "GRAPH"

In the GRAPH mode, the K101-D plots 48 channel magnitude (vertical axis) versus time or memory cells on the horizontal axis.

1. Horizontal expansion by pressing the appropriate keys (H X 1, H X 3, H X 6, H X 12).

2. Vertical expansion by pressing "EDIT", and then entering the upper data limit. Then press "GRAPH".

Press "A-B"

This key simply transfers the contents of A MEMORY to B MEMORY.

Press "DATA"

This key allows the user to view the recorded data in which ever radix chosen.

Press "TIMING"

This key displays an actual timing chart of the recorded data.

1. Each timing train may be labeled by pressing the edit key, moving the cursor, and using any of the ASCII characters and numbers.

2. Vertical expansion / V24, V12, V6.

3. Horizontal expansion / H X 1, H X 3, etc.

4. Since only 24 lines of timing can be displayed at one time the page ↑ or page ↓ can be used to view the other channels.

2.3.2 Specify Key Section

Press "INTERFACE"

This display field allows the user complete manipulation of the GPIB AND RS232 interface parameters. The time and date of the real time clock can also be set.

GPIB Entry Possibilities:

Listen Only	CR/LF	Data Select
Address =	CR/LF + EOI	Time Select
Talk Only	CR	Command = ?
	CR + EOI	

RS232 Entry Possibilities:

Baud Rate =	110	1200	9600
	150	1800	
	300	2400	
	600	4800	
Stop Bits =	1		
	2		
Parity =	ODD		
	EVEN		
	NONE		
Word Length =	7 bits		
	8 bits		
Protocol =	NAK/ACK		
	CTS/RTS		
Command =	?		

Press "CLOCK SELECT"

The user now has the choice of six menu screens to set up the correct clocking arrangement for a particular problem. The "NEXT" key can now be used to step through the various clock menus.

Entry Possibilities:

1. Clock Menus
   - Internal
   - External Single-phased
   - External Multi-phased
   - Mixed Single-phased
   - Mixed Multi-phased
   - Internal Extended

2. Internal Clock Range
   0010 Nanoseconds to 1,000 microseconds

3. Clocks

	Clock	Enable
A Section	J,K	R,S
B Section	J,K	R,S
C Section	J,K	R,S

Internal A, B, or C Sections

Master Clock: Clocks input data into main memory.

Press "INPUT MODE"

This menu display is used to program channel operating mode.

Entry Possibilities

Input Modes	Sample Glitch Latch Demux (Xf - X8 Only)
Thresholds	TTL ECL VAR A ±9.99 V VAR B ±9.99 V (Assignable by probe)
Arming	Manual Auto Auto Stop if A=B Auto Stop if A<>B Auto Stop if A=B Within Limits Auto Stop if A<>B Within Limits

Press "TRACE CONTROL"

Sixteen separate selective TRACE-CONTROL levels are now available, each with its own menu screen to simplify the user's specification task (0 - F). Each level has four conditional commands – STOP, JUMP, ADVANCE, and SELECTIVE TRACE. The execution of each command within a control level can be made conditional to a uniquely defined 48-bit data pattern and delay count.

Instead of simply finding a specific spot in a program for recording, the K101-D actually follows the program flow. The instrument traces through complex data paths, recording not just one, but many precisely defined portions of the program flow along the way.

Entry Possibilities:

Level	16 Levels
Delay	Specified either in decimal or hex. Counted as Either occurences of Master Clock Cycles or of that level's advance pattern.
End Level	(0 - F)

Stop Conditions	Stop if data = S and sample count > delay Stop if data = S and sample count < delay Stop if data = S and sample count = delay Stop if data = S and sample count >= delay Stop if data = S and sample count <= delay Stop if data = S and sample count <> delay Stop if data = S Stop Always Stop Never
Stop Pattern	S = XXXX XXXX XXXX XXXX
Jump to Ø Never	J = XXXX XXXX XXXX XXXX
Advance Never	A = XXXX XXXX XXXX XXXX
Trace Always	T = XXXX XXXX XXXX XXXX

Press "LOGIC POLARITY"

This key simply allows the user to specify negative or positive convention logic on any of the 48 data channels.

Entry Possibilities

Polarity Assignable by channel for all 48 inputs.

Press "DATA FORMAT"

The data format menu is used to arrange the channels of the logic analyzer to suit the needs of the user.

2.3.3 Acquire Key Section

Press "ARM"

This key is used to initiate a recording with the K101-D.

Press "ADVANCE"

This key can be used to automatically advance the trace control level during a recording.

Press "M→A"

This key can be used to transfer the contents of high speed memory to display memory in the case of external clock loss.

Press "STOP"

This key will stop a recording in progress.

2.3.4 GPIB Section Keys

These keys are used in conjunction with the interface menu.

Service

This key simply puts a service request onto the GPIB Bus (SRQ).

Go To Local

This key is used to return the K101-D to control of the local user.

2.3.5 Self Test Key

This key is used to access an extensive series of tests to check system confidence. (Shift key must be used to access SELF TEST mode.)

2.3.6 General Keys

The remaining keys which are not designated in any certain section are used in conjunction with various dedicated keys.

"SAVE"

Allows the user to store a certain set of parameters in the CMOS RAM circuit.

"RECALL"

Used to recall the saved parameters

"SHIFT / RECALL"

Restores the display menu to its original format.

"EDIT"

Used in conjunction with "B" Memory. Data display editing is accomplished.

OPERATING MANUAL

K101-D LOGIC ANALYZER

SECTION III

SPECIFYING RECORDING PARAMETERS

3.1 Overview

The K101-D is an extremely versatile, high performance, general purpose logic analyzer offfering an extensive menu of digital recording parameters. Precise, flexible, comprehensive, and unique digital recordings can all be made easily by first entering the appropriate recording parameters to capture the information you need from each acquisition. Designed to offer both versatility and ease of use, the instrument's five major recording menus allow you to make very compact recordings of structurally complex programs and associated system timing characteristics. Familiarizing yourself thoroughly with all of the K101-D's specification parameters will greatly enhance your ability to quickly isolate logic problems in your system.

The five major recording Specification menu categories are; Input Mode, Logic Polarity, Clock Select, Data Format, and Trace Control. Several of these major menus are further divided into multiple screens to aid and simplify the actual specification definition and entry. Access to a particular menu is attained by simply pressing the key corresponding to that category. These keys are contained in the Specify section of the keyboard (see Figure 2.1). Once you've accessed a particular menu, the various choices available in that menu are obtained by first moving the blinking cursor field to the desired area and then using either the Choice keys (Next or Previous) or direct entry to select the right choice.

3.2 Input Mode Screen

The Input Mode Screen (see Fig. 3.1) allows you to specify three different types of parameters; Input modes, Threshold levels, and the Arm mode. Each of these categories has several choices available and will be discussed seperately:

3.2.1 Input Mode Selection

Flexible input conditioning is provided by four different input modes in the K101-D; Sample, Glitch, Latch, and Demux. The direct entry keys used for these modes are C-F respectively. Each input mode is present to allow detection of a variety of system conditions such as the logic states present at the sample clock expressions or noise spikes occurring between valid sample clocks. Proper input sampling not only will result in capturing the right information, it can also reduce loading of the system under test and simplify signal connections.

Input mode assignment is largely independent of other trace specifications; any input mode can be used with any clock mode. Note, however, that in

all Clock Select screens the Enable clock expressions for each section (C, B, or A) are used when and only when either Latch or Demux input mode is selected for all or part of that section.

The following description of the four input modes and how they relate to each other will help you decide which mode, or combination of modes, are appropriate for particular applications.

3.2.1.1 Sample Mode

Sample mode is the unit's most basic input mode. Inputs selected for the Sample mode are checked at, and only at, each active clock edge (as specified by the sample clock expression used for the pertinent data input section) to determine their current logic levels. Any threshold transitions that occur between sample clocks are ignored in this mode.

The total operation of the Sample mode during a recording cycle, however, is somewhat more involved. The logic levels present when a section's sample clock comes true are held in temporary Sample registers until that section's next valid sample clock and then displaced by the next sample (see Fig. 3.2). When the Master sample clock comes true (which may be at the same time or a different time than the section's sample clock), the current contents of all of the temporary Sample registers are presented to the Selective Trace Control. If the Master sample matches the requirements of the Selective Trace Control, the Trace is enabled for that sample and it is clocked into the instrument's high speed Memory, M. If the Master sample does not match the Selective Trace Control requirements, then that sample is discarded. Samples that are clocked into memory M are initially entered into location 512 and then shuttled forward in memory as the recording progresses. If no End of Acquisition signal (Stop command) occurs before the sample is clocked past memory location 000 then that sample and each following sample will be discarded from the front of memory and replaced by the sample following. This selective acquisition cycle is repeated indefinitely until a Stop command is issued from the Trace Control. When a recording is completed, the contents of memory M are then transferred to display memory A for your casual review.

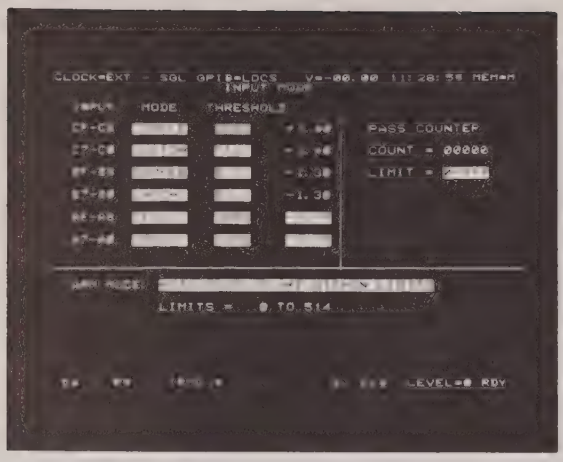

Figure 3.1 The Input Mode screen lets you select pertinent sampling parameters for each recording and also select the maximum number of recordings that may be attempted for each Arm cycle.

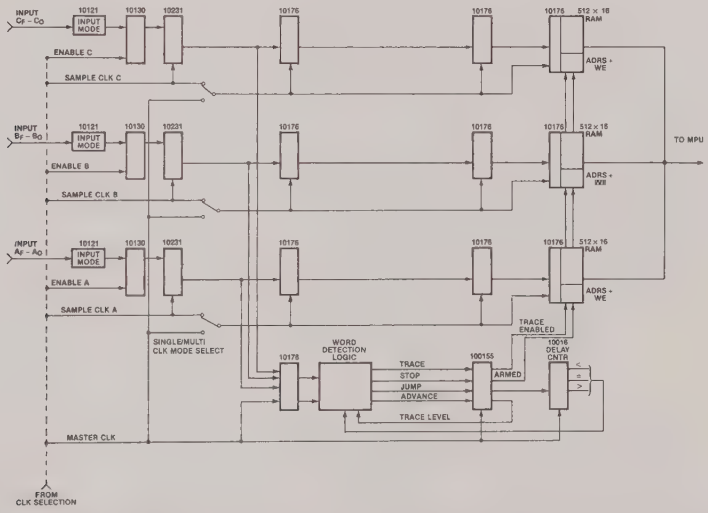

Figure 3.2 Block diagram of K101-D front end sampling circuitry. The multiple registers serve as a pipelined delay to allow time for each sample to be evaluated by the Trace Control for possible storage.

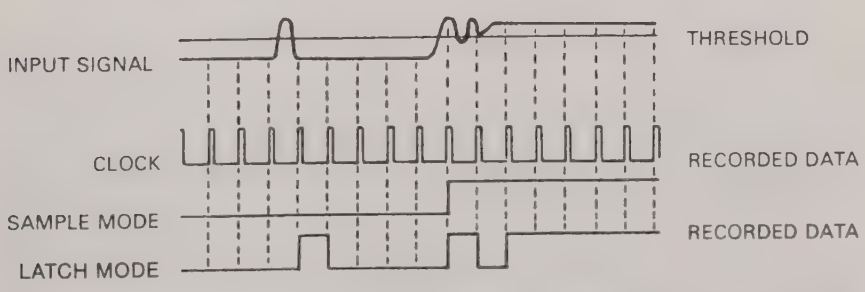

Figure 3.3 Finding noise spikes between sample clocks is easy with the K101-D's glitch mode. Any glitches between samples are stored as the next sample instead of the state present at that sample clock.

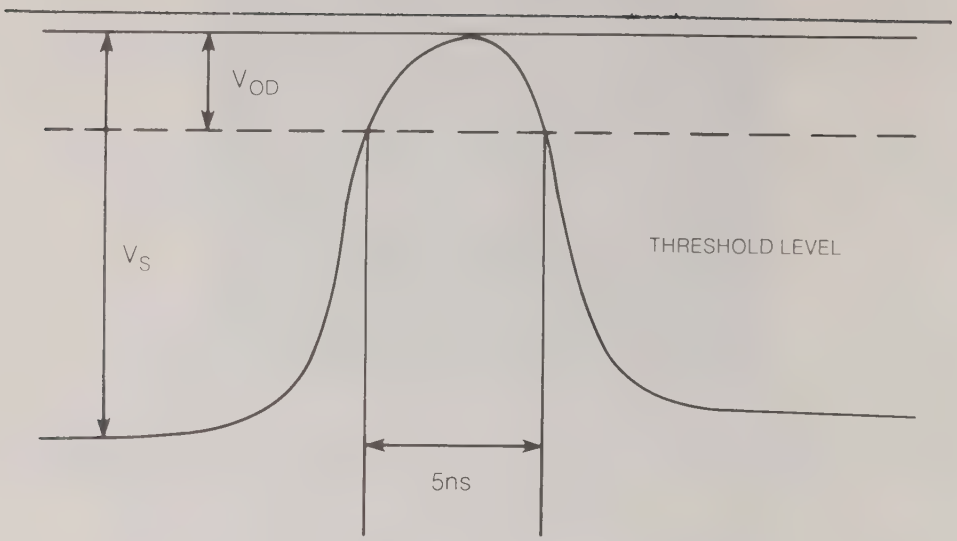

Figure 3.4 Typical response curve of K101-D probes to narrow noise spikes while in Glitch input mode.

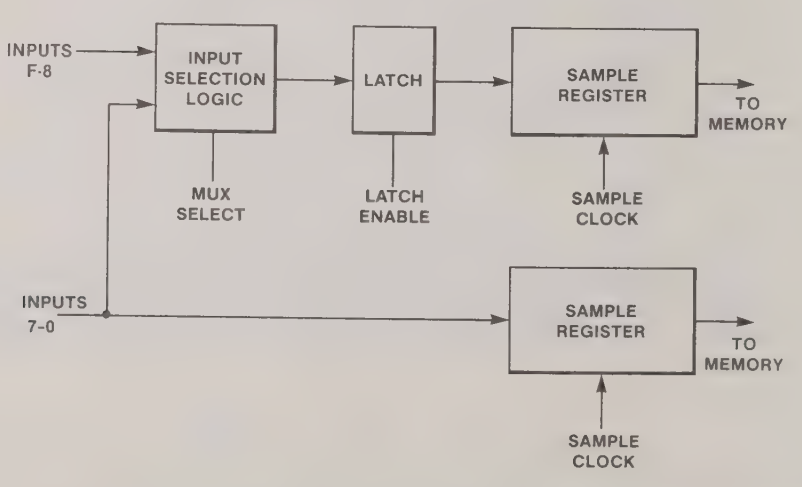

Figure 3.5 The Demux input mode allows you to probe multiplexed signals with a single probe to avoid unnecessary circuits loading and the physical hassle of double probing. The data inputs to the lower byte group of the section in Demux are buffered, then monitored in both Sample and Latch modes simultaneously. When the Section's Sample clock comes true the data present at that time is sent to the lower byte group of the trace memory (M) and the contents of the latch are sent to the upper byte group.

3.2.1.2 Glitch Mode

Glitch mode is present in the K101-D to help you detect glitches (possibly troublesome noise spikes or asynchronous threshold crossings between valid sample clocks) in your system that would not otherwise be captured. This input mode is handled by the K101-D in the same way as Sample mode except that the selected inputs are also monitored between every clock sample to determine if a glitch occurs (see Fig. 3.3).

If a glitch does occur between samples, it is held in the temporary sample register instead of the level present at the next occurrence of the sample clock. After the next sample clock, the sample register is reset. If no additional threshold crossings occur between the following sample clocks, the data held in the sample register will be the same as if the unit were in Sample mode.

Glitch capture is independent of the chosen sample rate; the glitch will be captured and stored as the next sample whether the unit is being clocked at a slow external rate or sampling at 100MHz. Absolute glitch capture capability, however, is a function of the sensitivity of the particular instrument and its probes, the threshold level selected, and the total energy above (or below) threshold contained in the glitch. A typical response curve is shown in Fig. 3.4. The sensitivity of your unit may be somewhat better or worse but should be similar. As noted in the Specifications section, to guarantee that a noise spike will be captured as a glitch by the K101-D, it must exceed the specified threshold level by at least 25% and have a pulse width at the threshold level of at least 5ns.

3.2.1.3 Latch Mode

Latch mode is a special case of Sample mode that allows you to either hold or pass data to half or all of the sample registers of each section (C, B, or A) based on the status of separately assignable latch Enable clock expressions. This feature lets you capture data at one time and sample it at a later time based on two separate clock expressions; the signals indicating valid data can be completely different in type and timing from the signals indicating the right time to sample that data.

When you select Latch mode a latch Enable clock expression is activated for the chosen inputs. Whenever that specified Enable clock expression is true, data passes directly to the corresponding Sample clock registers just as if the inputs were still in Sample mode. When the Enable expression goes false, however, the latch register inputs are disabled; the data present in the latch register at that time is held constant until the Enable expression comes true again.

The Sample clock actually looks at the current contents of the latch register rather than directly at the data inputs. If the inputs are selected for Latch mode and the Latch is enabled at that time, the data transferred to the Sample register will be the same as if those inputs

had been selected for Sample mode. If the Latch is disabled, the data transferred to the Sample register will the last data that was present in the Latch register when the Enable clock expression went false.

3.2.1.4 Demultiplex Mode

This mode lets you capture data present at two different times on the same bus lines for simultaneous evaluation by the Selective Trace Control as one sample. When Demultiplex mode is selected, the data inputs to the lower byte group of the selected Section (C, B, or A) are buffered and then sent to both groups of that Section (see Fig. 3.5). The lower byte group (0-7)is automatically placed in Sample mode and the upper byte group (8-f) in Latch mode. The Enable clock expression defined for that Section determines when and how the upper byte is sampled, just as in regular Latch mode. The Sample clock expression for the Section defines when the lower byte is sampled and also when the contents of the upper byte Latch are examined. Both bytes are presented to the Trace Control simultaneously as one valid sample.

The Demultiplex mode eliminates the need for double probing, allows more precise Trace Control, and results in a much more efficient use of memory when investigating multiplexed systems. Loading of your system is kept to same low level (1M , 10pF) as in normal sampling because only one probe connection is used.

3.2.2 Threshold Level Selection

Threshold levels are also selected from the Input Mode screen. The Threshold selection fields are located just to the right of their respective Input Mode selection fields (see Fig. 3.1 again). Up to four separate threshold settings for the K101-D can be used simultaneously to make each recording; fixed TTL (+1.40 V), fixed ECL (-3.3.31.40 V), and two variable thresholds (A and B, each settable to ±9.99V in 10mV steps with 20mV accuracy).

To change the threshold levels selected for a particular group of inputs, move the blinking cursor field down to that input group and over to the field showing the current threshold setting. Then simply select the desired threshold using either the Choice keys or direct entry (keys 8, 9, A, or B).

To specify the value for one of the variable thresholds, first move the cursor field to the pertinent input group and select that threshold. The current value of that variable threshold will appear in reverse video directly to the right. Move the cursor to that field and use direct entry (keys 0-9, +, -) to specify the desired value. Changing a variable threshold value in any input group will automatically change that value in all the other input groups where that variable threshold is selected.

3.2.3 Arm Mode Selection

The Arm mode is the final recording parameter selected from the Input Mode screen. This mode defines how new data acquisition cycle(s) begin and the conditions required for them to be completed. You can select either Manual, Auto,Auto Stop, or Auto Stop with Limits as the current Arm mode by locating the field selection cursor on the Arm mode field and using the Choice keys to scroll to the desired mode. Once the Arm mode is chosen, the actual acquisition cycle is initiated by pressing the Arm key. When each recording is completed, that recording is transferred to the Display memory (A) along with the time that the acquisition was completed. Each of the Arm modes are useful for different application areas and complement one another to offer very flexible operation:

3.2.3.1 Manual Arm Mode

A Manual Arm cycle initiates only one recording and stops at the end of that data acquistion. This mode is used for general system characterization and debugging.

If the unit is unable to find the conditions needed to complete the recording you can choose to halt acquisition at any time by pressing either the Stop key or the M-A key. When the Stop key is pressed, the machine cancels the attempted recording and leaves the same data in Memory A that was captured by the last completed recording; whatever new data was captured in Memory M is not accessed. When the M-A key is pressed, the current content of Memory M, (whatever is there; a partially completed recording, a random collection of data, or nothing), is transferred to Memory A. The new data, is accessed and whatever was in Memory A from the last completed recording is discarded.

3.2.3.2 Auto Arm Mode

The Auto Arm cycle automatically re-arms the K101-D after the first cycle is completed and continues indefinitely to re-arm the instrument after each subsequent recording. The same trace parameters are used for every recording cycle. After each cycle is completed the Data, Graph, and Timing displays are automatically updated to show the new data acquired. Auto Arm mode allows you to select the desired display and visually observe changes in system behavior as each new recording is completed.

Three different ways are provided to halt an Auto Arm cycle; pressing either the Stop or M-A key or completing the number of acquisition cycles entered in the Pass Counter field. The Stop and M-A keys function just the same as they do for a Manual Arm cycle which was described earlier. The Pass Counter, however, is only available in the Auto Arm modes and allows you to specify a limit on how many successive recordings the unit will make from the time the Arm key is pressed.

The Pass Counter entry field is located on the right side of the Input Mode screen (see Fig. 3.1 again) and can be accessed by moving the blinking cursor to that field. Once the field is blinking, you can enter any decimal value up to 65,535 as the Pass Counter limit using direct entry keys 0-9. Pressing the Arm key resets the pass count to zero and begins a new count (even if the unit is already armed). When the instrument reaches the specified number of completed acquisitions, recording stops automatically. As an additional aid, the count field above the Pass Counter entry field shows the number of acquisitions completed and is updated every time you enter the Input Mode screen display.

3.2.3.3 Auto Stop Arm Mode

The Auto Stop Arm mode extends the Auto Arm mode to automatically stop the instrument's recording cycle based on either "A equal to B" or "A not equal to B" being specified as the Stop condition. When the last recording made compares to the Reference memory contents in the manner specified, the recording cycle stops and that recording is held in Memory A for your casual review. Otherwise, recording can continue indefinitely just as in the Auto Arm mode. The Pass Counter, M-A key, and Stop key are all still available to provide further flexibility in halting recordings.

Once armed in the Auto Stop mode, (also known as the "baby-sitting" mode), the K101-D can capture intermittent faults without an operator even being present. As noted earlier, even the time of day that the intermittent occurs is captured and stored along with the recording.

Many Auto Stop applications are not searching for a definite intermittent, however, but rather trying to gain confidence that your system is functioning properly and consistently. Using both the Pass Counter and Auto Stop features together allows you to handle these applications easily by entering the number of times you want the instrument to look for the Auto Stop condition into the Pass Counter field. If the unit completes the specified number of recordings without finding the Auto Stop condition, the Pass Counter causes recording to stop anyway and the Input Mode screen will show that a full count of recordings was completed.

3.2.3.4 Auto Stop Within Limits Arm Mode

Auto Stop Within Limits is also available and lets you choose only a portion of the recording for the Auto Stop comparison rather than the whole memory. Thus if even a portion of the recording is expected to remain stable for each new acquisition you can still use the Auto Stop feature to check that stable portion. When this Arm mode is used, the data comparison is limited to only the inputs currently displayed from memory A (those selected using the Data Format field) and only from the A Cursor location through the A Reference location (or through the end of memory if the Reference is in front of the Cursor). Otherwise, Auto Stop Within Limits functions just the same as the Auto

Stop Arm mode, including the use of the Pass Counter, M-A key, and Stop key as alternate methods to stop a recording cycle.

3.3 Logic Polarity Screen

The logic polarity of all 48 data inputs can be selected individually from this screen using either the Choice keys or the "Plus" and "Minus" keys. Normal polarity is assumed positive; a signal above threshold is considered as a one and a signal below threshold is considered as a zero. As Figure 3.6 shows, all inputs are assigned horizontally to their respective section (C, B, or A) and within that section are labeled left to right as F-0. When either of the Choice keys are used, the selected input simply reverses from positive to negative or negative to positive. If the Choice key is held in, that input will continue to change polarity until the key is released. When either the "Plus" or "Minus" key is used, the currently selected input changes to the specified polarity and the blinking cursor selection field moves automatically to the next input within that section. If either of these keys is held in, the selection cursor field will continue to index to the next input within the section, changing each input to the specified polarity as it moves.

Once you've selected the desired polarities, a new recording must be made before the new polarities are reflected in the data captured; only recordings made after changing the Polarity screen will show the new specifications. This feature eliminates confusion over what conditions were used to make a recording and also prevents erroneous interpretation of existing recordings. New polarity specifications should always cause a new and different recording to be captured as long as the effected inputs are used for pattern recognition in a relevant Selective Trace Control level. The logic polarities specified effect the data patterns seen by the Selective Trace Control levels as well as the sense of the recorded data.

Display of new data in either the Data or Graph mode will show the information with the selected polarities. In the Timing mode only the binary cursor readout is adjusted; the Timing display always shows the signals as though they were all recorded using positive logic.

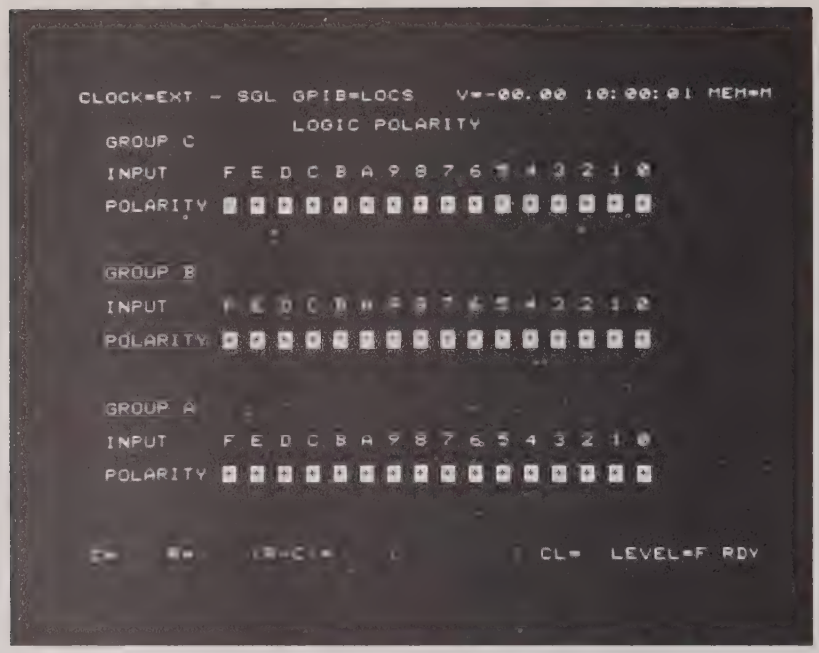
CLOCK=EXT - SGL GPIB=LOCS V=-00.00 10:00:01 MEM=M
LOGIC POLARITY
GROUP C
INPUT F E D C B A 9 8 7 6 5 4 3 2 1 0
POLARITY
GROUP B
INPUT F E D C B A 9 8 7 6 5 4 3 2 1 0
POLARITY
GROUP A
INPUT F E D C B A 9 8 7 6 5 4 3 2 1 0
POLARITY
CL= LEVEL=F RDY

Figure 3.6 The logic polarity of each data input can be specified individually. Trace capture data and graphic displays are influenced by the states chosen.

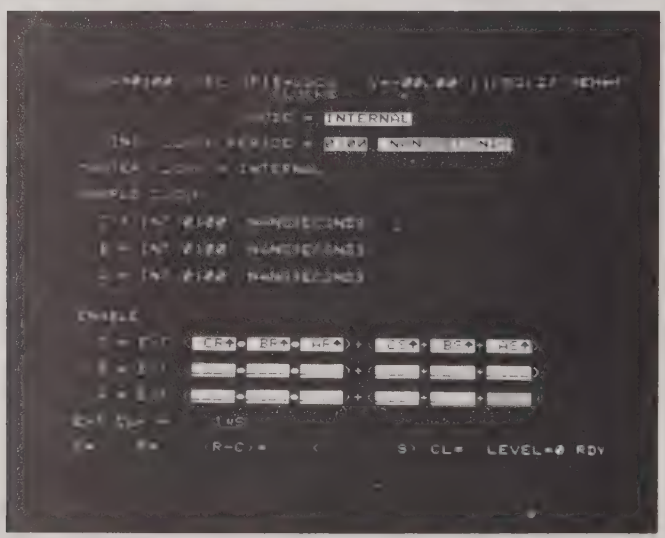

Figure 3.7 The six Enable clocks are shown on the lower third of this Clock Select screen, all selected for a rising edge or high state in Section C.

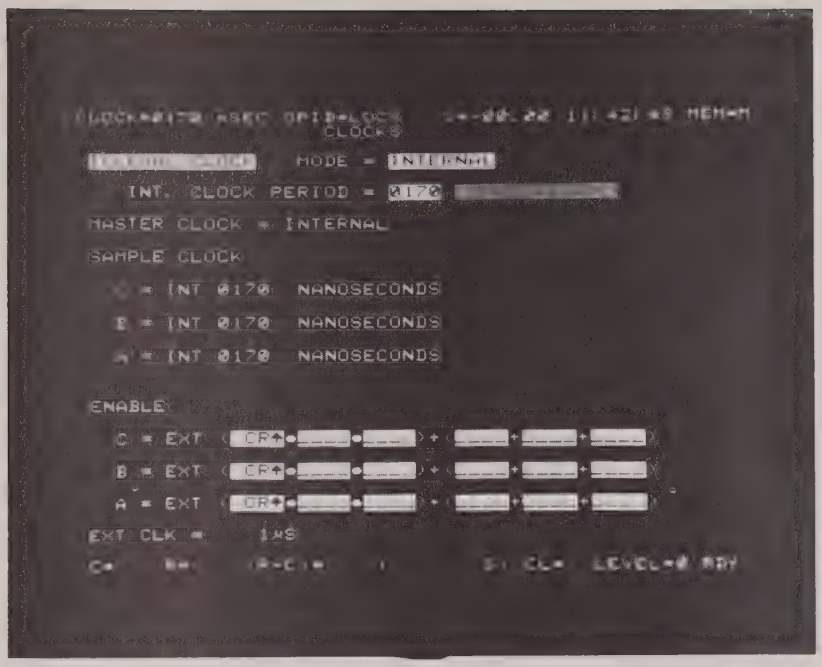

Figure 3.8 Internal mode Clock Select screen.

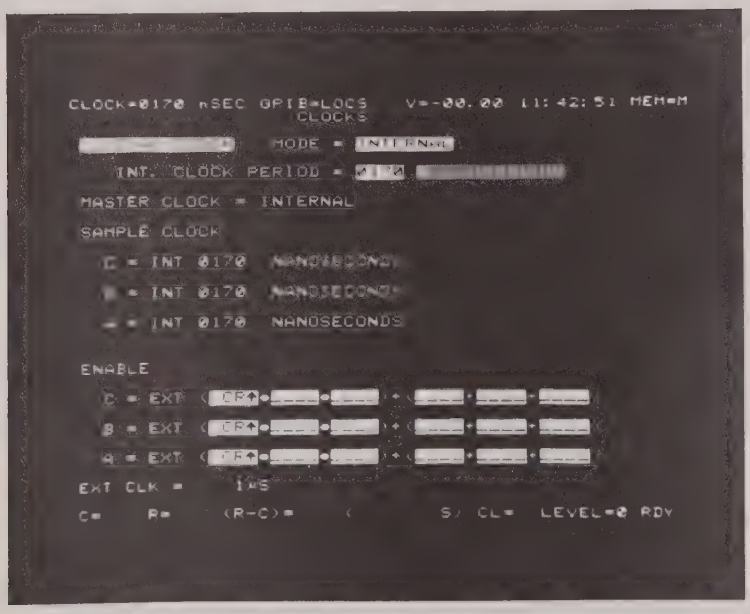

Figure 3.9 Correct selections of the internal clock rate are aided by the error message "Illegal Clock" which appears whenever a non-valid rate is chosen.

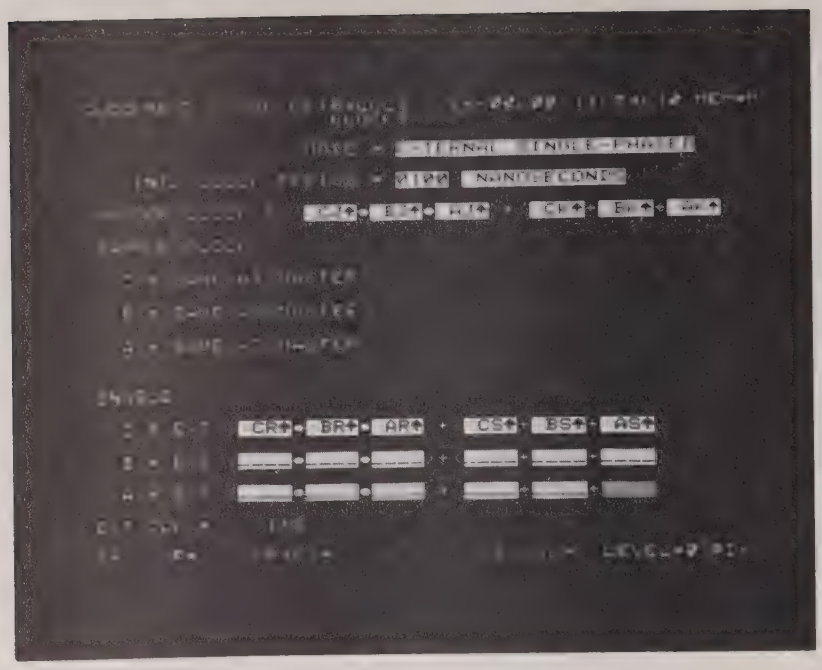

Figure 3.10 The six sample clocks are shown as the Master Clock expression, all selected for a rising edge or high state. The six Enable clocks are also shown as the Latch Enable expression for section C.

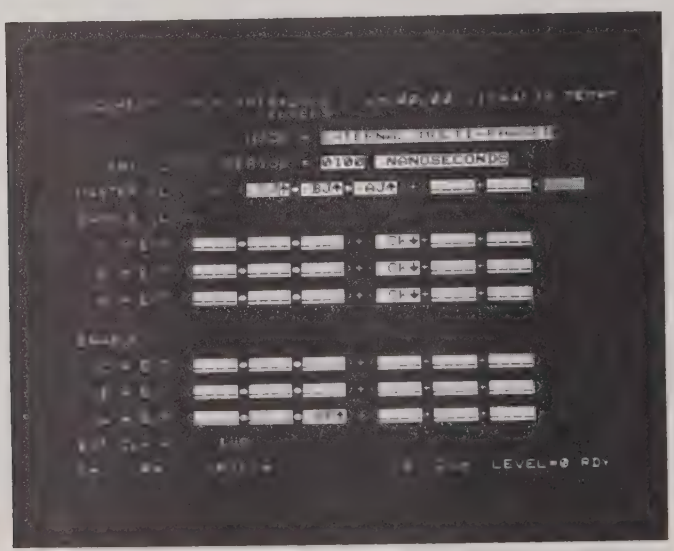

Figure 3.11 External Multi-Phased mode Clock Select screen.

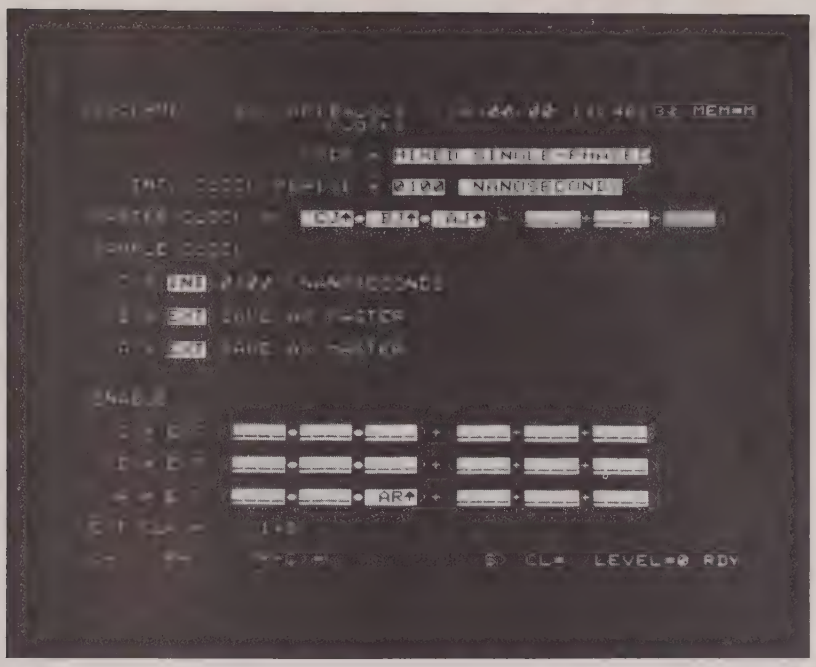

Figure 3.12 Mixed Single-Phased mode Clock Select screen.

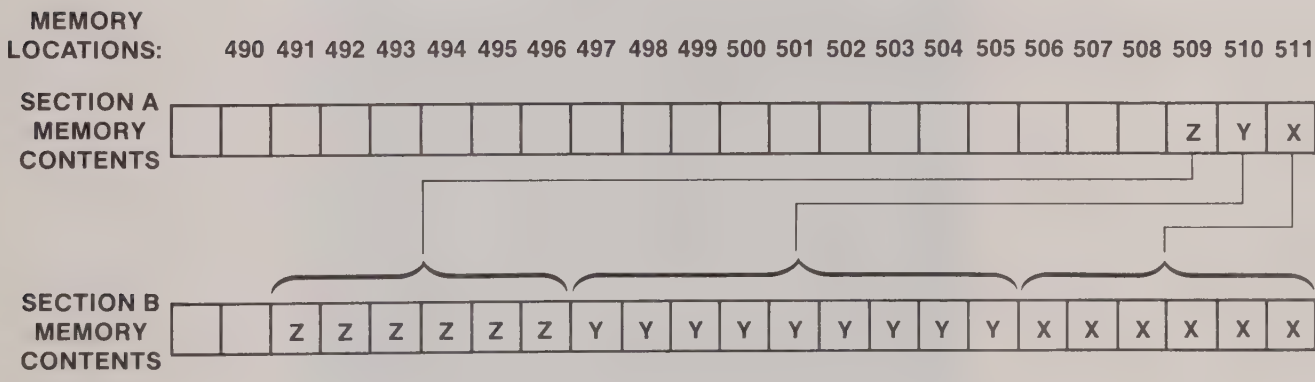
MEMORY LOCATIONS:
490 491 492 493 494 495 496 497 498 499 500 501 502 503 504 505 506 507 508 509 510 511
SECTION A MEMORY CONTENTS
Z Y X
SECTION B MEMORY CONTENTS
Z Z Z Z Z Z Y Y Y Y Y Y Y Y Y X X X X X X

Figure 3.13 Mixed mode acquisitions by definition contain information captured with unrelated, asynchronous clock signals. In this example the entire memory contents of Section B was captured during the same period of time that the last few words were captured in Section A.

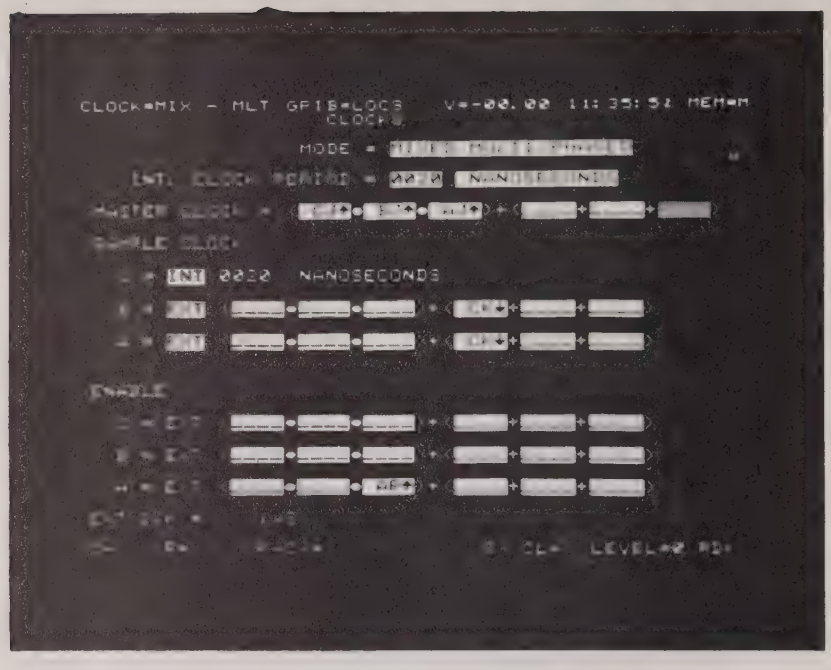

Figure 3.14 Mixed Multi-Phased mode clock Select screen

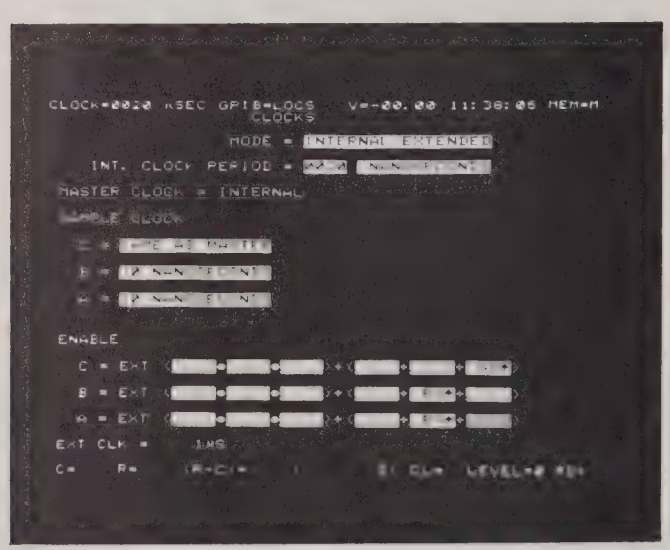

Figure 3.15 Internal Extended mode Clock Select screen

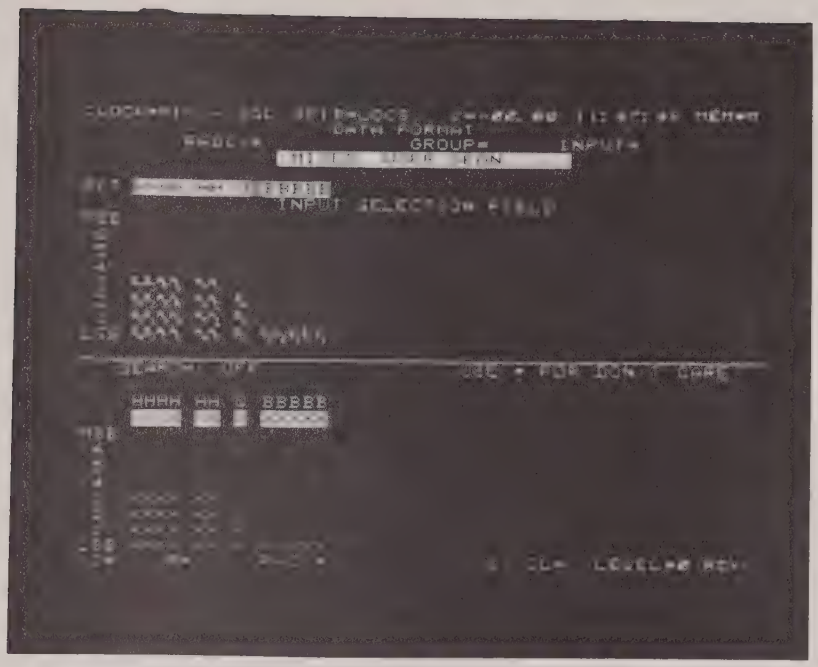

Figure 3.16 Mixed User sequence Data Format screen. Your choice of Binary, Octal, Hexadecimal, ASCII, and EBCDIC radices. Using any of the 48 data inputs whenever you want, you can form up to 48 columns of separately defined characters for data displays tailored.

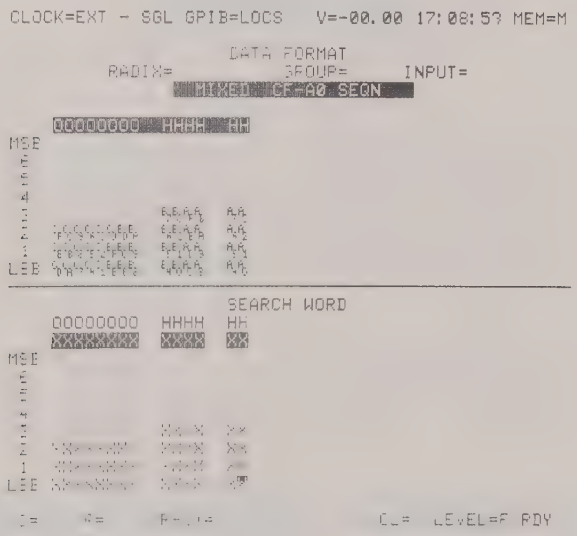

Figure 3.17 Mixed C_F-A_0 Sequence Data Format screen.

This screen provides flexible radix definition for each character and automatically assigns the data inputs needed to form those characters.

Figure 3.18 The 8085 Disassembler Data Format screen is an example of a Device Mnemonics display.

```
CLOCK=EXT - SGL GPIB=LOCS   V=-00.00 17:09:44 MEM=M

                    DATA FORMAT

                 DEVICE NOT AVAILABLE

    OOOOOOOO  HHHH  HH
MSB
 6
 5
 4
 3
 2
 1
LSB

                    SEARCH WORD
    OOOOOOOO  HHHH  HH
MSB
 6
 5
 4
 3             XXXX  XX
 2  XXXXXXXX   XXXX  XX
 1  XXXXXXXX   XXXX  XX
LSB XXXXXXXX   XXXX  XX

 C=    R=    (R-C)=    (        ) CL=  LEVEL=F RDY
```

Figure 3.19 When no Personality Module is in use, paging to the Device Mnemonics screen shows the preceding mixed format selection and the message "Device Not Available".

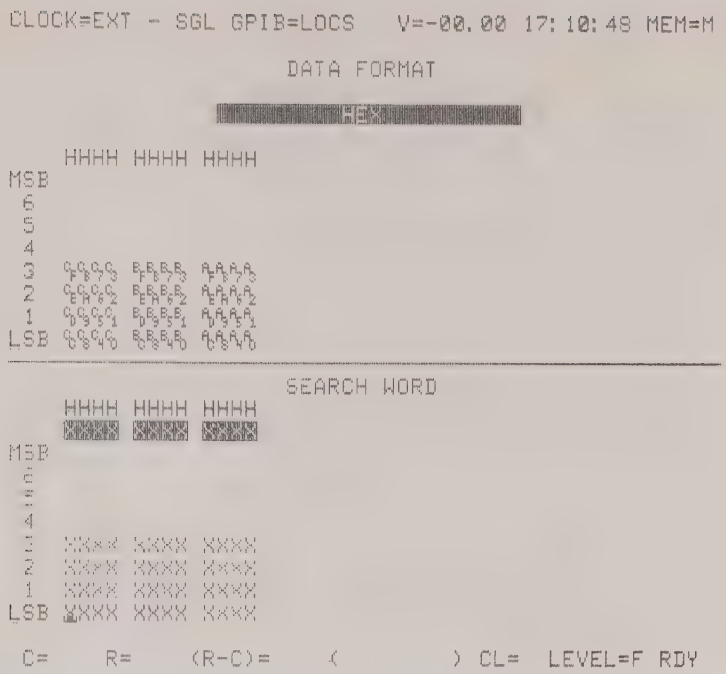

Figure 3.20 A Fixed Hexadecimal display lets you quickly review all data input formatted as hexadecimal characters.

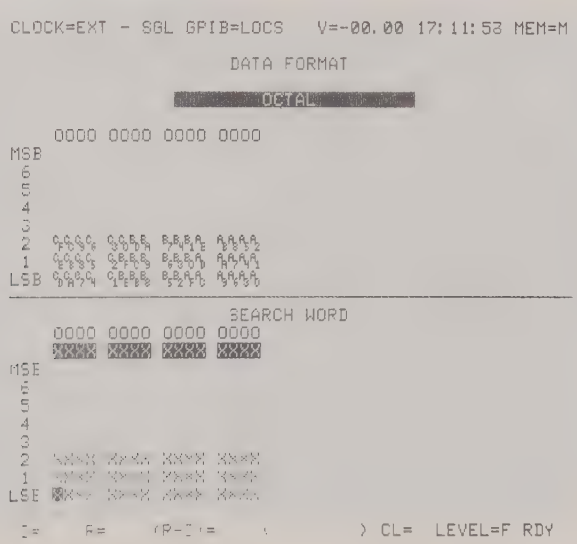

Figure 3.21 A Fixed Octal display lets you quickly review all data input formatted as Octal characters.

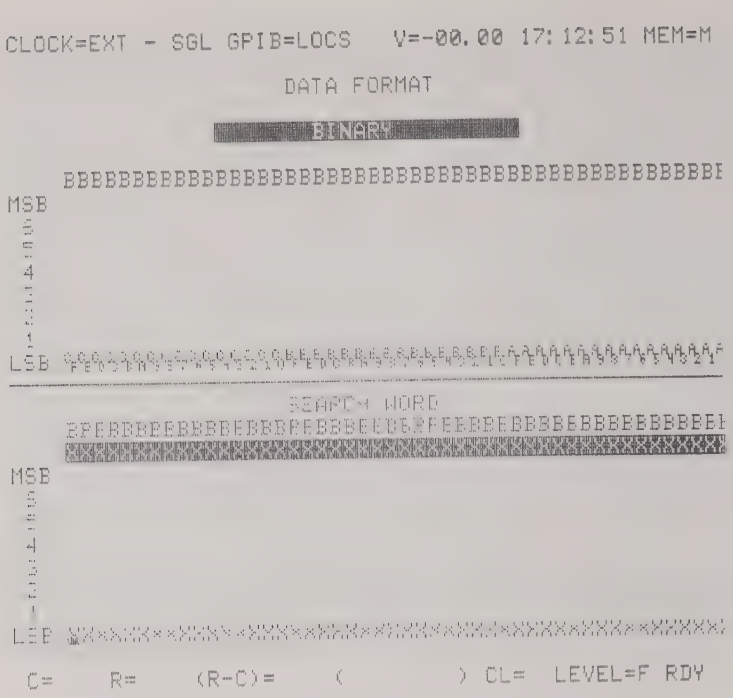

Figure 3.22 A fixed Binary display lets you quickly review all data inputs individually as binary characters.

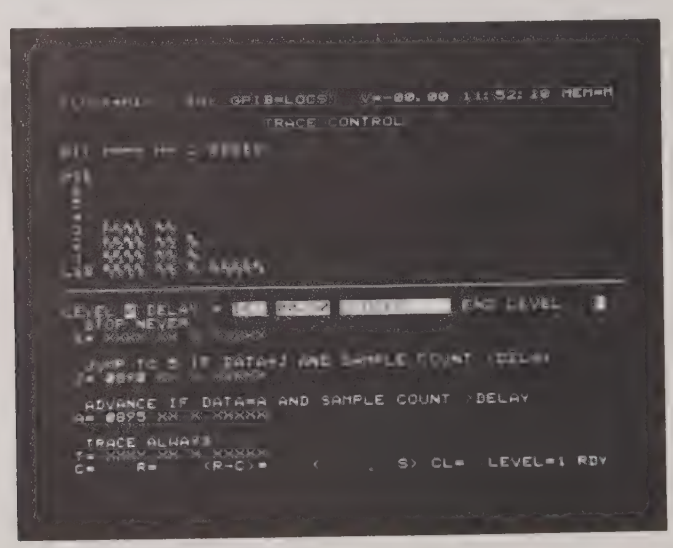

Figure 3.23 This Trace Control screen shows the current level 0 selections that wil be used for capturing the next recording in Memory M.

3.4 Clock Select Screens

GENERAL DESCRIPTION

The ability to look at digital data at just the right times for a particular test problem is a crucial prerequisite for efficient logic analysis. In order to capture relevant data you must first understand the timing characteristics of your system and how those characteristics relate to the flow of data through the system. Next, you should be able to easily specify the precise clocking scheme needed to investigate that data flow in an efficient manner. A wide variety of directly accessable synchronous and asynchronous clocking arrangements are provided by the K101-D to ensure you of this capability for almost any parallel bus system. Using the K101-D's Clock Select screens you can make very comprehensive yet efficient synchronous (data domain) recordings, precise and detailed asynchronous (time domain) recordings, and even mix synchronous and asynchronous recordings during the same acquisition. Sophisticated synchronous external clocking options allow you to easily monitor complex multiplexed and multiphased systems requiring both ANDed and ORed control signals for proper definition of valid data. A large number of asynchronous internal sampling rates offer precise timing resolution from 160 ms to 10 ns. Mixed data acquisitions are available to provide simultaneous collection of both data and time domain information.

The K101-D's Clock Select options are subdivided into six separate screen menus: Internal, External Single-Phased, External Multi-Phased, Mixed Single-Phased, Mixed Multi-Phased, and Internal Extended. Of these six menus there are really only three primary clocking modes; internal, external, and mixed. The Internal, External Single-Phased, and Mixed Single-Phased menus are all three subsets of the Internal Extended, External Multi-Phased, and

Mixed Multi-Phased menus respectively and are present to save you keystrokes when you want to enter the same clock expression into all three sections (C, B, and A) that you are using for the Master Clock expression.

Access to the six screen menus is obtained by pressing the Clock Select key. This causes the currently specified clock menu to be displayed and places the Selection Cursor at the top of that screen in the Mode field. Using the Choice keys while in this Mode field, you can scroll either forwards or backwards to the desired menu screen.

The Enable clock fields function independently of the specific menu mode and are present in all modes. Before considering each mode separately we will therefore first discuss the function and use of the Enable clock fields.

3.4.1 Enable Clocks

The Enable Clocks, occupying the bottom third of each clock menu screen, are formed by menu driven Boolean expressions of six separate latch Enable Clocks (see Fig. 3.7). These clocks are level sensitive and are used to gate or hold data in high speed input latches for possible later examination by their respective section's Sample clock expression. This capability is useful in several application areas such as collecting data from systems with a multiplexed bus, collecting data from systems requiring a negative hold time for the clocks relative to the data, and for filtering irrelevant data from timing acquisitions. When you're collecting data from a multiplexed bus, the Enable fields let you define the control signal(s) for sampling and holding the data that comes true first on the bus for simultaneous presentation to the Trace Control with the data that comes true later on the bus as defined by that section's Sample Clock expression. When you're collecting data from a system requiring a negative hold time for the clocks relative to the data, the Enable fields let you use some earlier signal (such as the system's primary clock) to catch the data while it is still valid and hold it until the correct sample clock comes true (such as the system's Read and Write signals which allow more efficient data capture). Very sophisticated filtering of data for timing analysis can be accomplished by using the control signals indicating known invalid time periods on your system's bus (such as when the bus is floating or tri-stated) to prevent these irrelevant states being presented to the Trace Control and resulting in the wrong data being captured.

Whether a particular section's Enable clock expression is pertinent for a given recording is determined solely by the current Input mode(s) selected for that section. If either Latch or Demux modes are selected for an Input group then the Enable expresion will be active and control the data Latch for those inputs. If either Sample or Glitch modes are selected then the Enable expression for that group is irrelevant.

Assuming that either Latch or Demux Input modes were selected, when the expression used for an Enable field is true, data passes through the input latches transparently. When the expression goes false the data present at that time is held in the input latches indefinitely until the expression comes true again. The expression is true when either all three AND clocks are true or when any of the OR clocks is true. The three ANDed Enable

Clocks are CR, BR, and AR. The three ORed Enable Clocks are CS, BS, and AS. Although the same clocks are used to define the Enable fields for all three sections and are presented in the same order, totally different expressions are possible for each section since each clock field can be selected as either active high, active low, or excluded from the expression.

To enter or modify the Enable clock expressions move the Selection Cursor down to the row containing the expression for the pertinent section and then across to the specific clock field(s) you want to change. Use the Choice keys to select the desired status for each clock field (active high, active low, or not selected).

3.4.2 Internal Mode

Internal mode allows you to make asynchronous timing measurements with resolution from 160 ms to 20 ns. All three sections are sampled simultaneously at the Master clock rate which is entered into the Int. Clock Period field (see Fig. 3.7). This field is broken into two subfields. The first subfield is used to enter the numerical value of the sample rate and the second subfield is used to specify the units used for sampling . No other fields need to be entered in this mode unless you are using the Enable Clock fields (which, as mentioned earlier, are specifiable from any mode) .

To select the desired sample rate, first move the Selection Cursor to the second subfield and use the Choice keys to select the units used for sampling (nanoseconds, microseconds, or milliseconds). This will help you in choosing a legal numerical sample rate since some values are not legal for all units. Next, return to the first subfield and use direct entry (keys 0-9) to specify the numerical value of the sample rate. Overall, valid rates are selectable in a 1 through 16 sequence. For example, rates such as 10, 20, 30, 40, and 50 microseconds through 160 microseconds are all valid choices while rates such as 11, 24, 78, and 170 microseconds (which do not follow a 1 through 16 sequence) are not valid choices. Entry of leading zeros is unnecessary; as soon as you enter the first number into the field the instrument automatically adds the leading zeros for you.

If you should try to enter an illegal clock rate the error message "Illegal Clock" will appear just to the left of the Mode field (see Fig. 3.9) to tell you that that rate is not allowed. When this condition occurs, you will be locked out from leaving the Int. Clock Period field until a valid rate is selected.

3.4.3 External Single-Phased Mode

The External Single-Phased mode uses the Master Clock to synchronously sample all three sections. This Master Clock is formed by a menu driven Boolean expression consisting of six separate Sample Clock fields. (see Fig. 3.10). The form of this expression is identical to that of the expressions used for the Enable Clock fields (three ANDed clocks ORed with three ORed clocks). The six Sample Clocks, however, are each edge sensitive rather than level sensitive like the six Enable Clocks.

The Master clock expression is used not only to control the data presented to the Trace Control but also for accumulating the Sample Count within each Trace Control level whenever Clock Delay is used. The Trace Control, on a sample by sample basis, can enable or disable the memory inputs for all three sections.

When the expression used for the Master Clock **comes true**, the K101-D passes the data present at that time through the pipeline for evaluation by the Trace Control as a potentially valid sample for Memory M. The expression **is true** when either all three AND clocks are true or when any of the OR clocks is true. The three ANDed Sample Clocks are CJ, BJ, and AJ. The three ORed Sample Clocks are CK, BK, and AK.

To either enter or modify the Master Clock expression, move the Selection Cursor down to the Master Clock and across to the specific clock field(s) you want to change. Use the Choice keys to select the desired status for each clock field (active high, active low, or not selected).

3.4.4 External Multi-Phased Mode

The External Multi-Phased mode (see Fig. 3.11) allows you to specify a separate Sample Clock expression for each section in addition to specifying the Master Clock expression. When recording in this mode, the data for each section is first clocked into a sample register by that section's Sample Clock expression. Every time one of the Sample Clock expressions comes true, new data is placed in that section's sample register and the old data is discarded. When the Master Clock expression comes true, the current contents of all three section's registers are sent through the pipeline to be evaluated concurrently by the Trace Control. Whether or not that Master sample is stored, one count is added to the sample counter in the current Trace Control level (assuming delay by clocks is being used in that level).

The form and entry of the Sample clock expressions is exactly the same as for the Master clock expression and uses the same six sample clocks.

3.4.5 Mixed Single-Phased Mode

The Mixed Single-Phased Mode (see Fig. 3.12) lets you record asynchronous timing information in one or more sections while using an external clock defined by the Master Clock expression to present synchronous data to the Trace Control and to record that data in the sections selected for external clocking. Each section's Sample Clock can be selected for either the "Same As Master" or for the currently specified Internal clock period by moving the Selection Cursor to that section's Sample Clock field and using the Choice keys to select either "EXT" or "INT". When "EXT" is selected "Same As Master"appears in the second half of the field. When "INT" is selected the current Internal clock period appears in the second half of the field. Note that when all three sections are selected for "EXT" the unit will record just as though it were selected for External Single-Phased mode. Alternately, by selecting all three sections for "INT" you can capture asynchronous timing information from all 48 inputs simultaneously while still using an externally derived Master clock expression to present only valid synchronous data to the Trace Control.

NOTE: **For successful analysis of recordings made in the mixed clocking modes, you must consider the correlation between data captured in separate sections using different sample rates. No fixed relationship exists between the data presented to the Trace Control (or that captured in the externally clocked section(s)) and the timing information captured by the internally clocked section(s). As each consecutive external clock occurs, an additive skew accumulates between preced-**

ing external clocks and the timing information corresponding to those clocks (see Fig. 3.13 for a typical example). The time between clocks is not constant because the Master Clock expression forming the clocks is usually composed of several control signals whose timing is dependent on the types of instructions and machine cycles being executed. Recording the signals used to form the Master Clock expression on some unused inputs of the asynchronous section(s) is the best way to synchronize the data captured between sections. Beginning from the word just before the end of memory (location 513; P-1) every location in the asynchronous section(s) where the Master Clock comes true corresponds to one sample in the synchronous section(s).

3.4.6 Mixed Multi-Phased Mode

The Mixed Multi-Phased mode (see Fig. 3.7) extends the Mixed Single-Phased mode to allow you to also use separate external Sample Clock expressions for each section. An external Master Clock expression is always used to present data to the Trace Control. Each section can be selected for either "EXT" or "INT". When "EXT" is selected, you can enter an expression for that section's Sample Clock. This expression can be just the same as or entirely different from the expression used for the Master Clock expression. When the external sample expression(s) used are just the same as the Master Clock expression, the unit will record data in that section as though you were using the External Single-Phased mode. When a different external sample expression is used, recording for that section will occur as though you were using the External Multi-Phased mode. When a section is selected for "INT", that section is sampled at the rate currently specified in the Int. Clock Period field and recording occurs as though you were using the Mixed Single-Phased mode. Entry is very similar to that used in the Mixed Single-Phased mode except that when "EXT" is selected for a section, that section's Sample Clock expression appears next to the "EXT" instead of the "Same As Master" message.

3.4.7 Internal Extended Mode

The Internal Extended mode (see Fig. 3.15) allows you to make asynchronous recordings at a 10 ns (100 MHz) sampling rate for very high resolution of system timing characteristics. All three sections are capable of simultaneously recording at a 10 ns rate and can be individually selected for that rate from this mode. The Master clock is also selected for an internal rate (any legal clock from 160 ms to 20 ns) using the standard Int. Clock Period field. Each section can either be sampled at that slower rate or at 10 ns intervals. To select the desired option for each section move the Selection Cursor to that section's Sample Clock field and use the Choice keys to select either "10 nanoseconds" or "Same As Master".

The reason that the Master Clock is selected for a slower rate is to be certain that the Trace Control functions properly. Because of the complexity of the decisions that must be made by the Trace Control between every sample, 20 ns is the fastest rate that data can be reliably evaluated. In practice, while this restriction should be understood, the real consequences are very small. When changing levels or when using Selective Trace in this mode, the captured data may shift a sample or two at the de-

cision points because of the difference in sample rates between the section(s) and the Trace Control. For example, if the Trace Control is clocked at 20 ns intervals and the sections are clocked at 10 ns intervals, the resulting recording will have an uncertainty at each trace decision point of ± 20 ns rather than ± 10 ns. At all other points in the trace the actual data will be recorded with a 10 ns accuracy.

NOTE: The same type of additive skew discussed in connection with mixed clocking will occur in the Internal Extended mode if you select sections to sample at a different rate (either not all "10 nanoseconds" or not all "Same as Master"). Since the internal rates are constant ratios of one another, however, this skew between sections does accumulate at a constant rate. Once understood, you can use this mode to gather data covering a longer time period with a lower resolution and a shorter time period with a higher resolution, both tied to the same recording parameters and traced during the same acquisition. If all three sections are operated at the same rate, no skew will occur.

3.5 Data Format Screens

How the K101-D's 48 data inputs are grouped and displayed is controlled by changing the Data Format screens. The format of words used in the Trace Control and Search fields as well as the format used to display the contents of Memory A and Memory B are determined simultaneously by the selections made using these screens. Only the top half of each screen is used to specify Data Format; the bottom half is used for entering Search words.

Five of six separate basic format screens are always available; these screens are labeled "Mixed User Seqn" (Mixed Radices, User Defined Sequence), "Mixed CF-A0 Seqn" (Mixed Radices, Fixed Sequence), "Hex", "Octal", and "Binary". A sixth screen, "Device Mnemonics", is available only when using device specific accessories and shows the disassembly data format used for those devices. The two mixed format screens are the only ones that allow you to specify radices or data inputs. Using either of these two screens, you can display simultaneously your choice of binary, octal, hexadecimal, ASCII, and EBCDIC radices. The Hex, Octal, and Binary screens each allow fixed display of all inputs in the chosen radix.

Only one Data Format screen can be used at a time; the one that was last selected. To select a different screen, (or to review the current screen), first press the Data Format key. The display will change to the current Data Format screen and the Selection Cursor will be on the Screen Selection field. Use the Choice keys to change screens. Entry within the two mixed format screens is a separate issue and is explained in the following general discussion of each of the six Data Format screens.

3.5.1 Mixed Radices, User Defined Sequence

This screen provides the most flexible data formatting available. Up to 48 separate columns of data characters can be specified for simultaneous display, each character defined using the radix of your choice and each radix composed using the data inputs of your choice. Binary, Octal, Hex,

ASCII, and EBCDIC characters can all be mixed indiscriminately to show data in whatever format is best suited to your system and application.

Character placement and definition are accomplished by moving the Selection Cursor down to the Column Specification field immediately below the Screen Selection Field (see Fig. 3.16). The Selection Cursor will flash over the first definable column and you can use direct entry (key "9" for EBCDIC, "A" for ASCII, "F" for Hex, "E" for Octal, "B" for Binary, or "*" for a blank space) to select the desired radix for that column. The Selection Cursor will then drop down into that column's Character Definition field to the location of the most significant bit needed to define that character in the chosen radix. (The Choice keys may also be used to select the radix, however, when you've scrolled to the right radix you must use the Cursor Down key to enter that column's Character Definition field). Each data input is identified first by its section (C, B, or A) then by its location within that section as input F-0. Use direct entry (keys C, B, or A followed by F-0) to identify the desired data input for that position. When the most significant bit has been defined, the Selection Cursor automatically steps down to let you enter the next bit and so on until the least significant bit has been defined for that character. The Selection Cursor will then return to the next column of the Column Specification field to let you define the character desired for that column. This process can be continued until all 48 columns are defined or until you have specified all of the columns appropriate for your application. Each data input can be used as many times as needed in any column or position desired.

Once you've entered a Character Definition field you must enter all the data inputs needed for the specified radix. However, if you make a mistake and enter the field accidentally or realize half way through that you're specifying the wrong character, you can press the Delete key to cancel character definition for that column. The partially specified character will be immediately eliminated and the Selection Cursor will return to the Column Specification field.

The Insert and Delete keys allow you to quickly change and rearrange the Data Format screen in either of the mixed formats. Whenever you are in the Column Specification field, pressing the Insert key will cause a space to be inserted at that location by moving the currently specified character for that column and all following columns one space to the right. By repeatedly pressing or holding down the Insert key, you can add as many spaces as you want (until the point when the rightmost defined character reaches the end of the Column Specification field which means the maximum number of 48 columns has been defined). Each space can either be left as a space or used to enter a new character. Pressing the Delete key while in the Column Specification field eliminates whatever character is specified for that column and moves all following columns one space back to the left. You can delete all but the last character by repeatedly pressing or holding down the Delete key; at least one specified column must be left somewhere on the screen.

3.5.2 Mixed Radices, Fixed Sequence

This screen (see Fig. 3.17) functions very much like the other mixed format screen except that all data inputs are selected for you automatically in a fixed sequence (CF-A0). Seperate entry of each input is eliminated but you are required to connect the probes for all defined inputs to correspond to the fixed sequence specified rather than connecting them wherever is convenient. Which format screen is best to use for a particular application depends on the difficulty of attaching the probes to your system in a fixed sequence relative to the difficulty of attaching the probes in whatever manner is convenient and then entering each input separately to define each character.

Only the Column Specification field is used in this mode since entry of the Character Definition fields is not required (or possible). As you specify the radix for each character, data inputs will be automatically assigned to form each character beginning with data input CF. If all of the inputs through A0 are assigned, the next input selected will again be CF. You may specify as many characters as you need in whatever radix (Binary, Octal, Hex, ASCII, or EBCDIC) you desire using either the Choice keys or direct entry. The Insert and Delete keys just as in the first format screen.

3.5.3 Device Mnemonics

This screen (see Fig. 3.18) is only available when the Model K101-D Personality Module accessory is attached to the K101-D and shows the necessary format for disassembly of program flow. A fixed format of Address, Status, Data, and Flags is provided, depending on the microprocessor(s) or other devices that the Module supports. If no Module is connected, "Device Not Available" will flash in the Screen Selection field whenever this choice is passed. (See Fig. 3.19) No editing is available from this mode.

3.5.4 Fixed Hexadecimal

This screen provides a format for the fixed display of all 48 data inputs as Hex characters. Data inputs are assigned as CF-A0, each Section (C, B, and A) forming a separate word (see Fig. 3.20). No editing is available from this mode.

3.5.5 Fixed Octal

This screen provides a format for the fixed display of all 48 data inputs as Octal characters. Data inputs are assigned as CF-A0 and formed into 4 words composed of 4 Octal characters (see Fig. 3.21). No editing is available from this mode.

3.5.6 Fixed Binary

This screen provides a format for the fixed display of all 48 data inputs as individual Binary characters. Data inputs are assigned as CF-A0 and cover the entire Column Specification field (see Fig. 3.22). No editing is available from this mode.

3.6 Trace Control Screens

When the most efficient and applicable input, clocking, and data formatting have been determined, you still have the problem of isolating the essential portions of your system's program activity. Even when only valid and qualified data samples are considered, a typical digital system processes several million bytes of data per second. Capturing and reviewing more than a very small portion of that data in an intelligent manner can be a task ranging rapidly from tedious and impractical to humanly impossible. Earlier logic analyzers tackled this problem by offering a variety of features designed to help you capture a narrowly defined "window" of activity around some very specific event in the program flow. Features such as combinational triggering (bit-pattern recognition),delay by clocks, delay by events, multi-level triggering, and selective trace (trace only when certain data inputs are in specified states) provided a means of precisely defining the desired window.

While these triggering features are sufficient in many cases, they provide no means of capturing data separated in time by any significant number of samples. Only selective trace offers any means of recording time independent data and that data is restricted to such tasks as monitoring the status of an I/O port or specific memory location. Often, the true cause(s) of a program aberration occur a relatively long time before their effect is observed. Gaining an understanding of the interaction requires gathering segments of data around several separate areas of program activity rather than around just one area or only at one location.

The K101-D's Trace Control screens allow you to isolate and capture the essential portions of your system's program activity in a single, compact recording, even if they are widely separated in the program flow. Offering multi-level selective trace in combination with sophisticated control commands incorporating both pattern recognition and delay qualification, Trace Control allows rapid capture of complex and otherwise unobtainable data. All of the previously mentioned means of capturing information plus powerful new capabilities are available to you through use of Trace Control.

Once you've specified the other recording parameters, you'll probably find that these screens are the primary ones that you'll change when you want to make new recordings. Up to 16 separate selective Trace Control levels (0-F) can be specified for each recording. The Trace Control always begins at level 0. What level it stops on and how many levels you use for each recording is user specified; if the problem requires less than 16 levels of Trace Control you only have to enter the number of levels required. Each level is identical in form to the others and is provided with its own menu screen to simplify and speed the task of changing and reviewing the level's specifications. All of the specifiable parameters on each screen are contained on the bottom half of the screen (see Fig. 3.23). The top half of each screen is used to show the currently specified data format so you can easily tell which inputs were used to define each character of the data patterns contained within the level's conditional commands.

3.6.1 Types of Trace Control

An individual Delay count plus four basic conditional commands (Stop, Jump, Advance, and Trace) are offered at each level:

DELAY

Delay can be entered as either a Decimal or Hex number. Any value from 1 to 65,535 decimal counts (1 to FFFF in Hex) is acceptable. The Sample Count used for Delay is specifiable using either occurrences of the Master Clock or of the level's Advance Pattern. The Sample Count is re-initialized by each level entry.

STOP

Nine different commands can be used to immediately Stop tracing; Stop If Data = S; Stop Always; Stop Never; and Stop If Data = S And Sample Count >, <, =, ≥, ≤, or ≠ Delay. "S" may be any non-contradictory data pattern possible given the current format of the 48 data inputs shown at the top of the screen. All logical values for each specified character can be entered in "S" including "Don't Care" states.

Various combinations of the nine Stop commands allow you to specify all logical relationships of the Stop pattern, Delay, and Sample Count including "Stop Always" and "Stop Never" which are independent of any conditions other than whether the Trace Control is currently active in that level. "Stop if Data = S"allows you to use the Stop pattern independently of Delay. The remaining commands require both the Stop pattern to be true and the Sample Count to have the specified relation to Delay. By entering all "Don't Cares" in the Stop pattern field, you can effectively use only Delay as the condition for Stop.

Each of the other three basic Trace Control commands (Jump, Advance, and Trace) offer the same types of conditional commands and are used in the same manner. Stop has priority over the Jump and Advance commands; if all three come true simultaneously, the unit will Stop.

JUMP

If specified conditional command for Jump comes true, Trace control jumps immediately to user defined level (0-F) . The same nine types of commands are available as for Stop except that "Jump" replaces "Stop" and "J" replaces "S". A Jump can be used for either a partial or total sequence restart of the recording or to follow an alternate data path. Since the Trace Control looks for all four conditional command patterns simultaneously, the nature of the Jump and Advance commands allow you to also use them as ORed trace patterns. Jump has priority over the Advance command; if both commands come true simultaneously, the unit will execute the Jump command.

ADVANCE

When the Advance command comes true, the Trace control advances immediately to the next level . The same nine types of commands are available for Advance as for Stop. "Advance" replaces "Stop" as the command word and "A" replaces "S" for the pattern label. Using the various Advance commands where appropriate in each level allows you to follow extremely intricate sequential program behavior.

TRACE

Selective Trace recording of each valid data sample is decided based on whether or not that sample meets the level's specified trace conditions. These conditions are defined using the same nine types of commands available for Stop. "Trace" replaces "Stop" as the command word and "T" replaces "S" for the pattern label.

Trace commands are not prioritized relative to the Stop, Jump, or Advance commands; if one of these commands comes true, the unit traces or doesn't trace that sample independently of that command.

3.6.2 Trace Control Entry

Entry to the Trace Control screens is accomplished by pressing the Trace Control key. This will cause the unit to display the level 0 screen and places the Selection Cursor on the Level Entry field. To change the level displayed, use either the Choice keys or direct entry (keys 0-F).

Use of both the Choice keys and direct entry allow you change the Trace Control specifications within a level. The Choice keys are used for specifying either a Hex or Decimal Delay count, Master Clock or Advance Pattern occurrences for the Sample Count, and for choosing the desired conditional command for each basic command field. Direct entry is used to specify the delay count (keys 0-F when in Hex, keys 0-9 when in Decimal).

OPERATING MANUAL

K101-D LOGIC ANALYZER

SECTION IV

MAKING A RECORDING

4.1 Making A Recording

The four red acquisition keys on the lower right side of the K101-D's keyboard are used to initialize and control recordins. When you've entered all of the desired trace specification parameters for a recording simply press the Arm key and the unit will begin the recording. You can monitor a recording in progress by watching the status and level messages displayed in the lower right corner of the CRT screen. These messages are shown on every menu and data screen in the same location.

There are only three status messages; "BUSY", "AUTO", and "RDY". "BUSY" indicates that the unit is in the Manual Arm mode and attempting to complete a single acquisition. "AUTO" is used for all of the Auto Arm modes and indicates that the unit is armed currently and attempting an acquisition. "RDY" indicates that the unit has completed a recording in the Manual Arm mode, captured a recording meeting the Auto Stop Arm mode conditions, or has been manually disarmed.

Immediately following the Arm command, the unit transfers the current parameters to its high speed hardware, fills the Trace Memory (M) with all zeros, and fills the Trace Level Tracking Memory with all "F"s. During this time (and at the beginning of each subsequent Arm cycle if the unit is in one of the Auto Arm modes), an asterisk (*) is displayed as the level message.

When this initial portion of the Arm cycle has been completed, the Trace Control becomes active, advancing first from Level F to Level 0 when the first valid clock occurs. If external clocking is being used and the level message does not change from "F" then no valid clocks have occurred. As the unit advances, or jumps, fromTrace level to Trace level, the "0" will change to match the level currently controlling recording. If the unit hangs up at any level and is unable to find the required data, you can continue the recording from the next level by pressing the Advance key. When the acquisition has been completed the status message will return to "RDY" and the level message will show the level where a Stop condition was found. "RDY" indicates that the unit is not armed and is in a ready state to be armed.

Two keys are available to manually halt an acquisition, "M-A" and "Stop". If you press the "M-A" key during an acquisition, the current contents of the Trace Memory(M) will be transferred to the Display Memory (A), allowing you to review whatever data was present in memory M at that time. If you press the

"Stop" key recording simply stops and the data held in memory A remains intact. Either way, the status message will return to "RDY".

When one of the Auto Arm modes is being used, the same parameters used for the initial Arm cycle are used for each subsequent cycle. You can enter changes while the unit is armed but the new parameters will not be used until the Arm key is pressed again. Whenever the Arm key is pressed, an entirely new recording cycle begins. Whatever conditions are used to complete a recording are automatically transfered to Display Memory A along with the data to allow you to review how the data was acquired.

OPERATING MANUAL

K101-D LOGIC ANALYZER

SECTION V

RECORDING ANALYSIS

5.1 Data Mode

5.1.1 Display Formats

In Section IV-E, data format screens were discussed. The way in which these menus are set up control the way in which data is presented when you press the DISPLAY key DATA.

5.1.2 Data Searches

The lower half of the DATA FORMAT menu allows you to specify a word to be found by the instrument, in either memory A or B, whichever one is displayed when Search is ON.

The DISPLAY key SEARCH ON/OFF is an alternate action key. Data may be entered with SEARCH on or off.

There are two modes of specifying the search word.

a. By bytes, where you enter data in the same radix that you specified in the upper half of this menu.

b. By bits, where you can enter (in the MSB/LSB field) 1, 0, Don't Care bits. This gives you the ability to specify a hex byte, for example, and then specify a range of hex words by making one or more of the bits of the hex byte Don't Cares.

In the data domain photo, the tally at screen bottom shows two occurrences of the Search word, at memory location 139 and 395. An asterisk denotes the location of the word. The FIELD CHOICE NEXT key aloows you to sequence through memory from one Search word to the next.

5.1.3 Memory Comparison

You can compare the contents of A and B memories. The DISPLAY key COMPARE A/B is an alternate action key, and turns the Compare feature on and off.

A "not equals" sign denotes those locations in Memory A (B) that are not equal to the same memory locations in B (A).

By using DISPLAY A (or B), you can visually determine the exact differences between the two memories. The instrument finds and tallies the non-compares. The FIELD CHOICE NEXT key allows you to sequence through the memory. 5.1.4 Reference Editing

You can load or edit the B memory from the keyboard when it is displayed on-screen.

Press the EDIT key, causing a cursor to appear at the top of the left hand column of data. Position the cursor to the desired memory location, using the UP-DOWN FIELD keys.

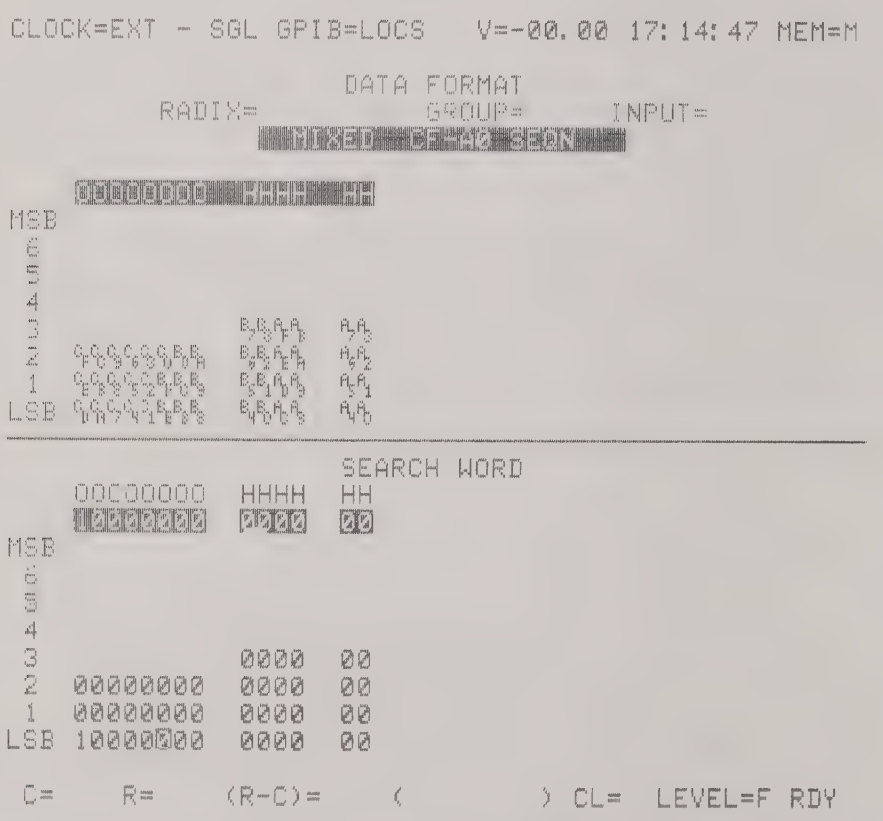

Figure 5.1 DATA SEARCHES. At CRT lower half, is ON. Line of hex, ASCII, octal, and binary allows byte level selection of search word. Column MSB/LSB allows bit level selection.

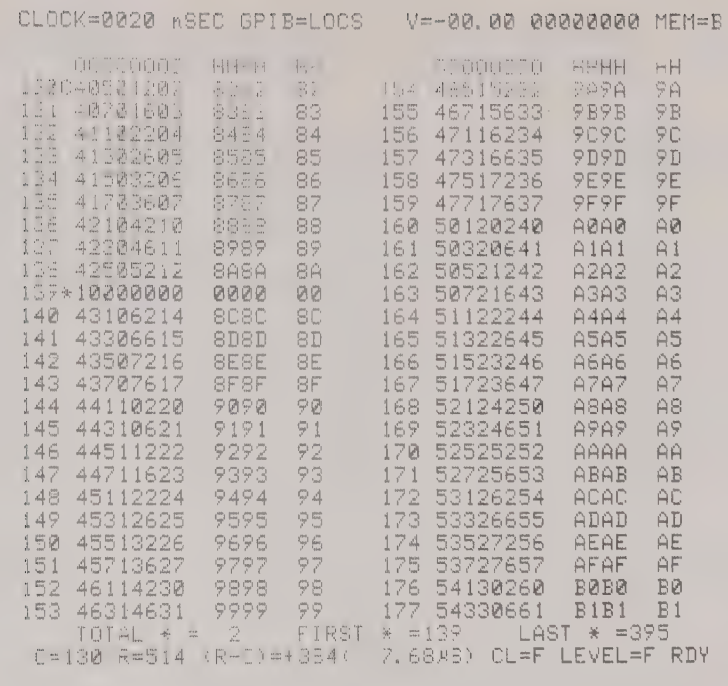

Figure 5.2 SEARCH TABULATION. Data entry at bottom of CRT shows that there were 2 words, at locations 139 and 395.

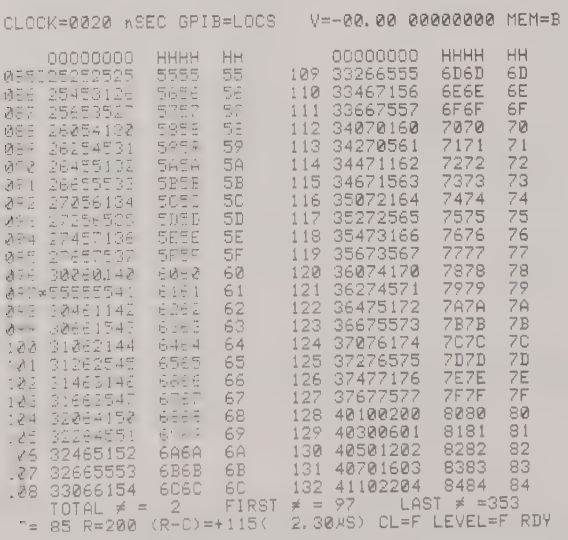

Figure 5.3 MEMORY COMPARISON: Data entry shows two non-compares, at locations 22 and 49. FIELD NEXT key shifts to subsequent locations.

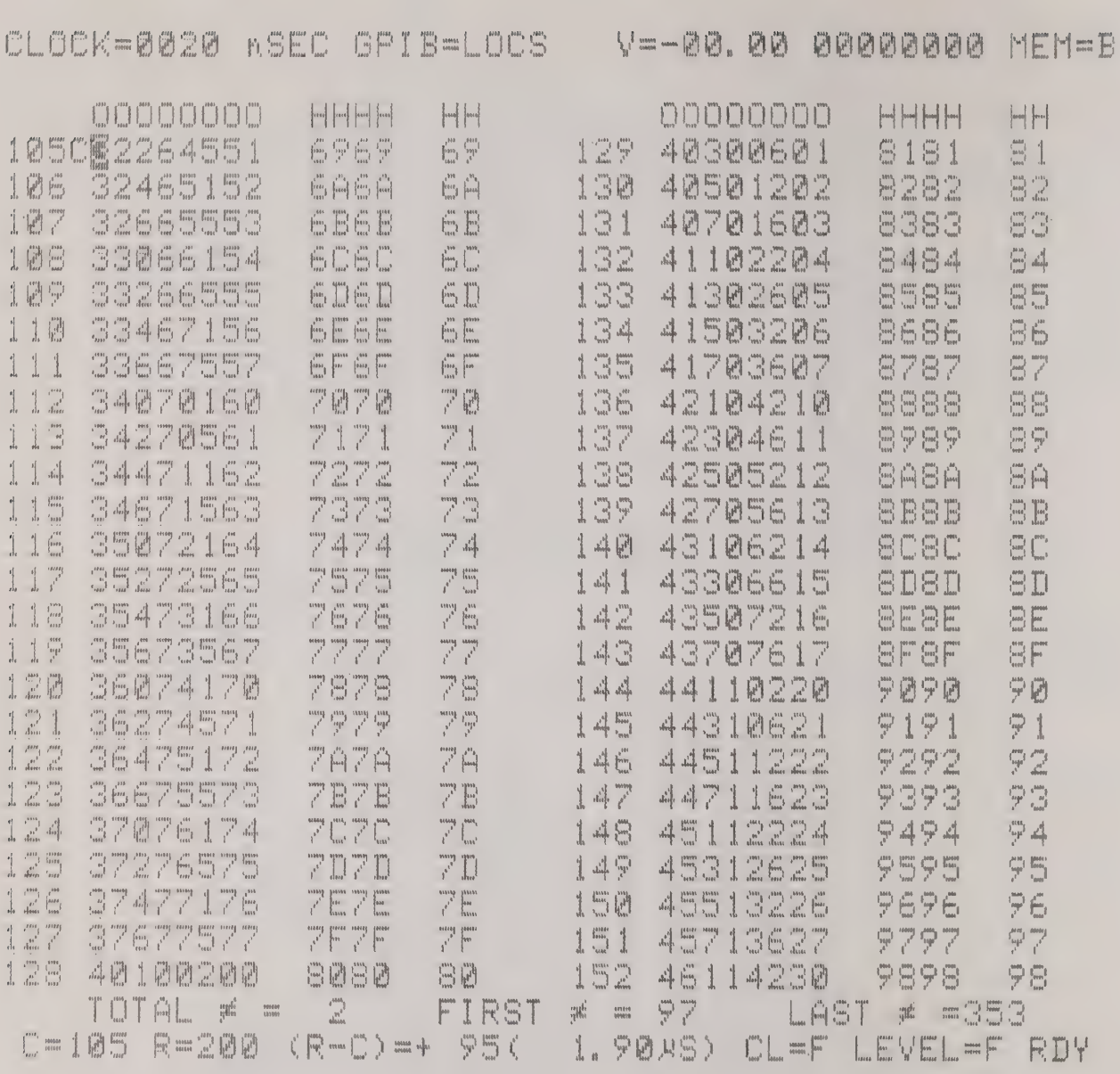

Figure 5.4 REFERENCE EDITING: Cursor is at location 105. You can write over the existing data, using the hex keys.

Use the LEFT-RIGHT FIELD keys to position the cursor to the byte to be changed. Using the keyboard, write over the existing entry.

a. Insert/Delete

You can use the EDIT cursor to insert or delete memory contents.

In the figure, the EDIT cursor is placed at memory location 105. The data stored is 6969 69 4 5 10. Press existing INSERT to clear the line to all zeros. This action also shifts all subsequent memory contents down one line. The last word in memory will be lost.

Line 105 can now be loaded with the desired data. There is no limit to the number of words that can be inserted; however, for each inserted word, the last word in memory is lost.

To delete data, use the EDIT cursor as above, and then strike the DELETE key. The data at that memory location will disappear, to be replaced with the data at the very next location. All data in memory gets shifted up. The last memory location gets loaded with zeros.

5.2 Graph Mode

The Graph mode provides an X-Y coordinate graph of the magnitude of the data value in memory vs. the memory location. the graph is actually calibrated in units of time. This feature provides a visual display of the contents of memory which is useful for determining if repeated occurrences of a particular data word occured or if data in memory is all within a particular range.

5.2.1 Data Selection

The portion of the word to be graphed is determined in the Data Format display. The data characters listed in the first 15 columns of the Column Specification field are the ones which are plotted. Data characters outside this range are ignored.

5.2.2 Data Range Limits

The upper and lower limits of the Y axis (data values) can be specified by the user. When graph mode is first entered the plotted data spans the range from 0000 0000 0000 to FFFF FFFF FFFF (assuming all 48 channels are being plotted). To change the limits, depress the edit key. Note the EDIT UPPER and LOWER fields which appear just beneath the X axis. The upper and lower limits of the Y axis can now be specified. Depressing the EDIT key again exits the EDIT mode and replaces the upper and lower limit data with C and R cursor data.

5.2.3 Horizontal Display Expansion

The display can be expanded in x3, x6, and x12 expansions just as in the timing trace display. The display is expanded from the C cursor position. The C cursor always appears on the left axis and moving the C cursor causes the display to scroll left and right when in expanded modes.

Displayed in the left margin of the graph are the Horizontal Scale, Number of selected channels and the memory locations shown.

5.3 Timing Mode

5.3.1 Vertical Display Expansion and Paging

The unit can display as many as 24 channels at a time. All 48 channels may be viewed by paging up and down. 6 at a time) or PAGE DOWN (pulls the channels up 6 at a time).

The V24 key displays all 24 channels, the V12 displays 12, and the V6 displays six channels.

5.3.2 Horizontal Display Expansion

You can expand horizontally by factors of 3, 6, and 12, by using H x 3, H x 6, and H x 12, respectively. Expansion takes place to the right of the cursor position.

To specify a CURSOR or REFERENCE go-to memory location, press SHIFT, CURSOR (REFERENCE) SET, key in the number of the memory location, and key TIMING.

5.3.3 Trace Sequence Modification

By using EDIT, you can replace existing channels with any other. The EDIT key turns on the cursor, which is positioned at the channel to be replaced by the FIELD UP/DOWN keys.

Use the hex keys, and key in the desired channel. Any channel may be used as many times as desired.

5.3.4 Trace Label Assignment

The EDIT cursor may be moved into the open field to the left of the timing traces using FIELD LEFT/RIGHT keys. This allows you to label each trace with any Seven alphanumeric character you desire.

For 0-7 and A-F characters, use the hex keys directly. For G-Z letters, key SHIFT for each character. SHIFT may be un-keyed by pressing it a second time.

5.4 Auxiliary Measurements

5.4.1 DVM

The Digital Voltmeter readout appears on all display formats on the top of the CRT (V = ± 00.00). The readout is real time, and can measure voltages between ± 20 VDC. Input impedance is 20 KΩ

5.4.2 Frequency Counter

This readout is in the clock Select menu, and is a latched value. The counter measures the period of the Master clock. The counter functions in any external clock mode. To update the counter measurement, key CLOCK SELECT.

The counter will give an average reading of the Master Clock, in the case of a clock whose period changes.

```
CLOCK=0020 nSEC GPIB=LOCS   V=-00.00 00000000 MEM=B

    00000000  HHHH  HH        00000000  HHHH  HH
105C00000000  0000  00    129 40100200  8080  80
106 32264551  6969  69    130 40300601  8181  81
107 32465152  6A6A  6A    131 40501202  8282  82
108 32665553  6B6B  6B    132 40701603  8383  83
109 33066154  6C6C  6C    133 41102204  8484  84
110 33266555  6D6D  6D    134 41302605  8585  85
111 33467156  6E6E  6E    135 41503206  8686  86
112 33667557  6F6F  6F    136 41703607  8787  87
113 34070160  7070  70    137 42104210  8888  88
114 34270561  7171  71    138 42304611  8989  89
115 34471162  7272  72    139 42505212  8A8A  8A
116 34671563  7373  73    140 42705613  8B8B  8B
117 35072164  7474  74    141 43106214  8C8C  8C
118 35272565  7575  75    142 43306615  8D8D  8D
119 35473166  7676  76    143 43507216  8E8E  8E
120 35673567  7777  77    144 43707617  8F8F  8F
121 36074170  7878  78    145 44110220  9090  90
122 36274571  7979  79    146 44310621  9191  91
123 36475172  7A7A  7A    147 44511222  9292  92
124 36675573  7B7B  7B    148 44711623  9393  93
125 37076174  7C7C  7C    149 45112224  9494  94
126 37276575  7D7D  7D    150 45312625  9595  95
127 37477176  7E7E  7E    151 45513226  9696  96
128 37677577  7F7F  7F    152 45713627  9797  97
    TOTAL ≠ =  2    FIRST ≠ = 97    LAST ≠ =353
 C=105 R=200 (R-C)=+ 95(  1.90uS) CL=F LEVEL=F RDY
```

Figure 5.5 INSERT: EDIT cursor is at location 105. Key INSERT, and you get all zeros at 105, and locations 105 through 515 move down one location. Key in new data at 105.

```
CLOCK=0020 nSEC GPIB=LOCS   V=-00.00 00000000 MEM=B

    00000000  HHHH  HH        00000000  HHHH  HH
105C32665553  6B6B  6B    129 40701603  8383  83
106 33066154  6C6C  6C    130 41102204  8484  84
107 33266555  6D6D  6D    131 41302605  8585  85
108 33467156  6E6E  6E    132 41503206  8686  86
109 33667557  6F6F  6F    133 41703607  8787  87
110 34070160  7070  70    134 42104210  8888  88
111 34270561  7171  71    135 42304611  8989  89
112 34471162  7272  72    136 42505212  8A8A  8A
113 34671563  7373  73    137 42705613  8B8B  8B
114 35072164  7474  74    138 43106214  8C8C  8C
115 35272565  7575  75    139 43306615  8D8D  8D
116 35473166  7676  76    140 43507216  8E8E  8E
117 35673567  7777  77    141 43707617  8F8F  8F
118 36074170  7878  78    142 44110220  9090  90
119 36274571  7979  79    143 44310621  9191  91
120 36475172  7A7A  7A    144 44511222  9292  92
121 36675573  7B7B  7B    145 44711623  9393  93
122 37076174  7C7C  7C    146 45112224  9494  94
123 37276575  7D7D  7D    147 45312625  9595  95
124 37477176  7E7E  7E    148 45513226  9696  96
125 37677577  7F7F  7F    149 45713627  9797  97
126 40100200  8080  80    150 46114230  9898  98
127 40300601  8181  81    151 46314631  9999  99
128 40501202  8282  82    152 46515232  9A9A  9A
    TOTAL ≠ =  2    FIRST ≠ = 97    LAST ≠ =353
 C=105 R=200 (R-C)=+ 95(  1.90uS) CL=F LEVEL=F RDY
```

Figure 5.6 DELETE: New data is at 105. To delete, move EDIT cursor to 105, and key DELETE. All data in memory will move up. Data will then look like photo labeled "Reference Editing".

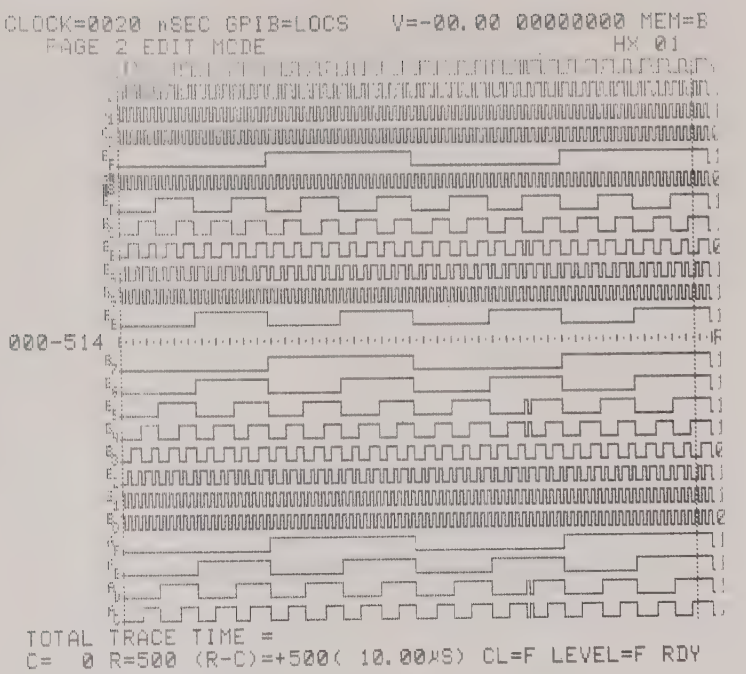
CLOCK=0020 nSEC GPIB=LOCS V=-00.00 00000000 MEM=B
PAGE 2 EDIT MODE HX 01
000-514
TOTAL TRACE TIME =
C= 0 R=500 (R-C)=+500(10.00uS) CL=F LEVEL=F RDY

Figure 5.7 TRACE SEQUENCE MODIFICATION. EDIT cursor is at position formerly occupied by channel BE. Channel B8 is now positioned there.

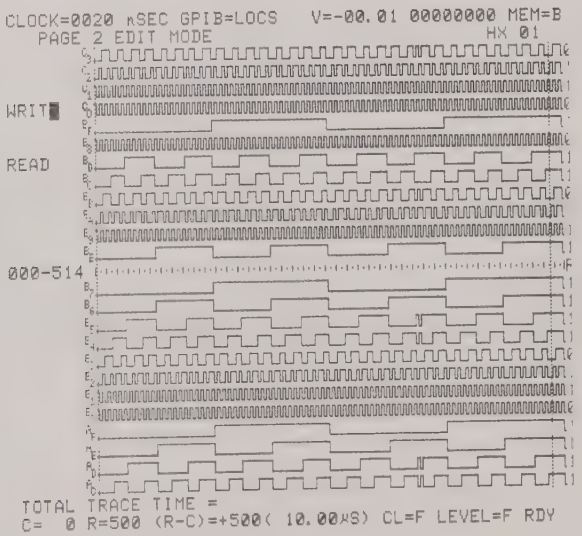

Figure 5.8 TRACE LABEL ASSIGNMENT. EDIT cursor moved to left of timing traces and a label is keyed in.

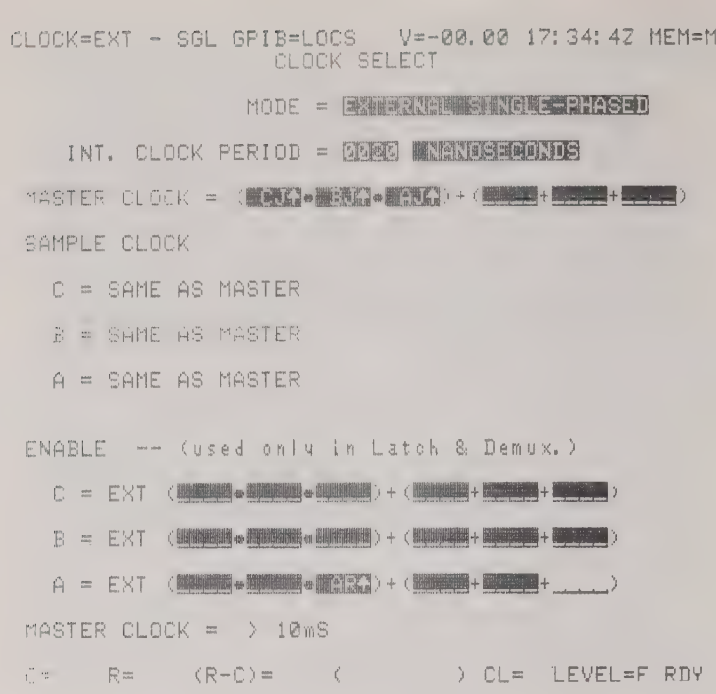
CLOCK=EXT - SGL GPIB=LOCS V=-00.00 17:34:42 MEM=M
CLOCK SELECT
MODE = EXTERNAL SINGLE-PHASED
INT. CLOCK PERIOD = 0000 NANOSECONDS
MASTER CLOCK = (C + B + A) + (+ +)
SAMPLE CLOCK
C = SAME AS MASTER
B = SAME AS MASTER
A = SAME AS MASTER
ENABLE -- (used only in Latch & Demux.)
C = EXT (+ +) + (+ +)
B = EXT (+ +) + (+ +)
A = EXT (+ +) + (+ +)
MASTER CLOCK =) 10mS
C= R= (R-C)= ( ) CL= LEVEL=F RDY

Figure 5.9 AUXILIARY MEASUREMENTS. DVM, TOD clock, and counter are all displayed in this photo. Key CLOCK SELECT to update counter display.

5.4.3 TOD Clock

This clock measures actual time of day, and is backed up by the internal battery.

Time is entered on the INTERFACE menu. Use the FIELD keys to position the cursor, and the numeric keys to enter values. When the second digit of the seconds field is entered, the clock starts timekeeping.

The month-day-year, and time-of-day information are loaded into a register at the end of a recording. Thus, when you examine or photograph the CRT, you have a convenient record of the exact time of the recording.

K101/102 INTERFACE ADDENDUM

OPERATING NOTE

MARCH 1982

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SECTION IV
COMMUNICATIONS INTERFACING

4-1. INTRODUCTION

In general, the GPIB and RS-232-C interfaces allow the user to operate the K101-D/K102-D from the GPIB controller in a manner comparable to pressing keys when the K101-D/K102-D is operated from the front panel keyboard. Each key on the front panel (except the AC power switch) can be logically "pressed" with the appropriate command. The only way to hold a key in a continuously "pressed" position (e.g., to cause a cursor to move continuously) is if the terminal is equipped with an auto repeat function.

Both interfaces utilize the same Record Formats to perform data transfers, which are specified in Section 4-5. The operating modes, parameters and selections unique to GPIB and RS-232-C operations are specified in Section 4-2 and 4-4 respectively, including the interface selections allowable from the K101-D/K102-D front panel.

NOTE

This document contains preliminary information. Prior knowledge of the normal (non-GPIB) use of the K101-D/K102-D Logic Analyzer as contained in the Operation and Service Manual is assumed. For elaboration on specific points, or question regarding items not covered in the text, please consult the factory directly.

4-2. GPIB OPERATION

General Description

The K101-D/K102-D GPIB is an implementation of the IEEE GPIB STANDARD 488-1978. The K101-D/K102-D GPIB supports the following functions as defined by the STANDARD:

Source Handshake	(SH1)	Complete Capability
Acceptor Handshake	(AH1)	Complete Capability
Talker Function	(T5)	Basic Talker Talk Only Unaddress if 'MLA'
Talker Function Address Extension	(TE0)	No Capability
Listener Function	(L3)	Basic Listener

		Serial Poll Listen Only Unaddress if 'MTA'
Listener Function with Address Extension	(LEO)	No Capability
Service Request	(SR1)	Complete Capability
Remote Local Function	(RL1)	Complete Capability
Parallel Poll Function	(PP1)	Remote Configuration
Device Clear Function	(DC1)	Complete Capability
Device Trigger Function	(DT1)	Complete Capability
Controller Function	(CO)	No Capability

4-3. GPIB OPERATING MODES AND MESSAGES

Talk/Listen Mode:

LISTENER: As a listener, the K101-D/K102-D will process keys sent to its listen address while it is in remote mode. Six types of records may be sent to the K101-D/K102-D when it is addressed to listen. KEYSTROKE records, MEMORY records, COMMAND records, DISPLAY records, PORT records, and ACQUISITION TIME records.

TALKER: When the K101-D/K102-D is addressed to talk, it will send the type of record requested by the last COMMAND record. In some cases the requested data will take more than one record to send. In this case, the K101-D/K102-D will send one record each time it is addressed, or as long as it is addressed, until all of the requested data has been sent. After all requested data has been sent the K101-D/K102-D will not send anything, even though it may be continually addressed to talk.

Talk Only Mode:

LISTENER: The K101-D/K102-D has no listener capability in this mode.

TALKER: When the GPIB SRQ key is pressed on the K101-D/K102-D front panel, the PRINT records for the current screen are sent. If in INTERFACE mode, other "EXTERNAL" functions may be performed locally by entering keys in the GPIB COMMAND field. Keys entered here are processed as if they came over the GPIB bus from an external controller and so should conform to the formats specified. This field is only expected to be used to enter COMMAND record type data (although there is no restriction as to what type of talk records may be included in this field) and may only contain up to 8 characters. The desired GPIB record (up to 8 characters) should be entered, followed by a space (which will be interpreted in this field as a 'carriage return' terminator). The 'delete' key may be used to edit this field. When entered, a 'delete' will cause the most recently entered character to be deleted. If greater than 8 characters are entered, not including deleted characters, the oldest entries are deleted. Only the characters visible in the GPIB COMMAND field will be processed.

Listen Only Mode:

LISTENER: The K101-D/K102-D will process any messages sent across the GPIB. It will not look for its listen address before attempting to process a device dependent message.

TALKER: The K101-D/K102-D has no talker capability in this mode.

IFC Message:

The IFC message will clear the K101-D/K102-D interface (talker, listener, and serial poll states are set to idle). If the K101-D/K102-D is in the process of transmitting a talk record when an IFC occurs, the remainder of the record will be output the next time the K101-D/K102-D is addressed to talk. If the operator wishes to start sending a new record after an IFC, send a Command Record with the desired Talk Record command code.

Device Trigger:

Causes pulse to appear at BNC, located at the rear panel with TTL levels.

Using the command line on the Interface Screen:

The command line on the Interface Screen was designed to enter commands as if one were using a remote device.

They must begin with a "C," and they are executed by pressing the SHIFT and SPACE keys.

For example, the following key sequence CPA, SHIFT, SPACE from the front panel will send out the keystrokes required to set up the polarity for Memory A.

*NOTE:
In order for this command line to function for GPIB, the instrument must be in TALK ONLY MODE. The RS-232-C permits entry during any mode.

Device Clear:

This produces the same results as pressing the stop key on the front panel. In addition, it notifies the GPIB of an unnatural stop and reset the buffer and counters for GPIB transmittal.

K101-D/K102-D GPIB Status Byte:

If the K101-D/K102-D has requested service from the controller, the RQS bit (bit 7) of the STATUS BYTE will be set as defined by the GPIB standard. The RQS bit will remain set until after the controller performs a serial poll or a "CSR" command is received. The other status byte bits indicate the reason service was requested.

The K101-D/K102-D will request service under the following conditions:

1. End of K101-D/K102-D record cycle when not in the Auto Arm mode.
2. SRQ pressed (while in TALK/LISTEN mode) and in local (LOCS) or in local with lockout state (LWLS).
3. Error in power-up diagnostics.

4. GPIB listen record error (see following table).

The status byte bits have the following meaning:

BIT #	DECIMAL VALUE WHEN THIS BIT IS SET		MEANING
8	128		1 = Recording in progress
7	64		1 = K101-D/K102-D service request
6	32		1 = SRQ key pressed
5	16		1 = Error in power-up diagnostics
4	8	>	
3	4	>	Listen Record Error
2	2	>	
1	1	>	

Listen Record Error Codes:

0 = No error

1 = Illegal command code received.

2 = Illegal character received.

3 = Keyboard input error (local or remote source).

4 = Invalid character. Rest of record ignored.

Following a serial poll, all bits except bit 8 are reset.

K101-D/K102-D Parallel Poll:

The PPR (parallel poll response) assigned to the device is represented according to the sense bit (bit 4) of the PPE (parallel poll enable message) and the current service request state (Status byte bit 7) of the device.

Parallel Poll Response

N-A	RQS = 0	RQS = 1
Sense = 0	0	1
Sense = 1	1	0

EG. PPE - 0 1 1 0 1 0 0 0
="="=> PPR1
=====> Sense = 1

If RQS is true (service requested), the parallel poll response is 00000001.

If RQS is false then the parallel poll response is 00000000.

A parallel poll will not clear the service request. A serial poll should be conducted to determine the reason for the service request and to clear it.

Interface Mode Selections:

The following GPIB parameters may be selected from the front panel of the K101-D/K102-D using the INTERFACE MODE specify key.

MODE CHOICE - Select GPIB function.

TALK ONLY
LISTEN ONLY
ADDRESS=available address are 00-30 decimal
default address is 09.

END OF MESSAGE CHOICE - Select end of message characters.

CR (carriage return)
CR + EOI (carriage return and set EOI)
CR/LF (carriage return and line feed)
CR/LF + EOI (carriage return, line feed, and set EOI).

K101-D/K102-D Self Test Mode:

The GPIB is inactive when in the Self Test mode. Self Test mode cannot be operated via the GPIB.

4-4. RS-232-C OPERATION

General Description:

The K101-D/K102-D RS-232-C is a full duplex serial channel and provides full modem control for communications using telephone lines. In the INTERFACE mode, the RS-232-C channel baud rates, parity, word lengths, stop bits and protocol may be selected. The record format used by the RS-232-C interface is identical to that used by the GPIB.

Protocols And Errors:

There are two protocols available, "CTS/RTS" and "NAK/ACK." The "NAK/ACK" protocol INCLUDES the "CTS/RTS" protocol.

CTS/RTS: A standard modem/terminal handshake is assumed. The DSR line and CTS line are monitored to determine if a transmission can take place, and the RTS line is used to signal that a message is ready for transmission. This protocol can be defeated by wiring RTS directly to DSR and CTS, in which case a transmission will occur immediately and continue at the selected baud rate until the record is exhausted.

NAK/ACK: For situations where modem control lines are not available and buffering is required, the "NAK/ACK" protocol is used. This adds a software protocol to the previous hardware one. Before transmission in this mode, the receiver is checked for a NAK (Ctrl-S or 13H) character. If one is found, the transmission will not take place. Normally, the receiving device will transmit an ACK (Ctrl--Q or 11H) character when ready, and a NAK when not ready. This allows two devices of different processing speeds to synchronize.

NOTE

When an error is detected in an RS-232-C record, an ASCII NAK (15H) is sent. The conditions which would cause an RS-232-C error are identical to those which cause a service request to be generated in GPIB mode (see GPIB FUNCTIONAL SPECIFICATION - GPIB STATUS BYTE).

Interface Mode Selections:

The following RS-232-C parameters may be selected from the front panel of the K101-D/K102-D using the INTERFACE mode specify key.

Baud Rate - Select transmit/receiver rate in bits per second.

110	600	2400
150	1200	4800
300	1800	9600

Stop Bits - Select number of stop bits associated with each character.

1
2

Parity - Select the parity for each character.

ODD
EVEN
NONE (parity will not be checked)

Word Length - Select the number of bits per character.

7
8

Protocol - The RS-232-C Full duplex protocol to be used.

NAK/ACK
CTS/RTS

4-5. RECORD FORMATS

General Description:

All device dependent messages sent or received by the K101-D/K102-D are coded according to the record formats specified in this document. The record type depends on the type of information to transfer. Records which can be sent by the K101-D/K102-D when it is a talker will be referred to as 'talk records.'

Records which can be received by the K101-D/K102-D when it is a listener will be referred to as 'listen records.'

Record Types:

Keystroke Record:	K101-D/K102-D keystrokes, represented as ASCII character codes. Talk and Listen record.
Memory Record:	K101-D/K102-D measurement data and trace level. Each sample is represented by two hexadecimal digits. Talk and Listen record.
Command Record:	Commands that control the K101-D/K102-D GPIB functions. Listen record.
Status Record:	GPIB Status Byte information and K101-D/K102-D recording status. Talk record.
Display Record:	A string of characters to display on the K101-D/K102-D screen. Listen record.
Print Record:	A copy of the characters displayed on the K101-D/K102-D screen. Talk record.
Port Record:	Data read from specified port. Talk and Listen record.
Acquisition Time Record:	Time, date and trace time for acquisition. Talk and Listen record.
DVM Record:	DVM reading. Talk record.

All of the information sent in a record is ASCII encoded. ASCII spaces and/or commas may be inserted in a record to improve readability (except in Display and Acquisition Time records). There is no limit to the size of listen records. However the K101-D/K102-D talk records do not exceed 80 characters to accommodate controllers with limited input buffer space.

All records begin with a record type character, and end with a terminator character. When using the GPIB interface records may be terminated with a 'CR',

or a 'CR' 'LF'. The terminator character(s) used may be selected locally while in the INTERFACE mode, or remotely by appropriate GPIB keys. GPIB listen records may be terminated in either way.

NOTE

Record Types: Are used for both GPIB and RS-232-C interfaces.

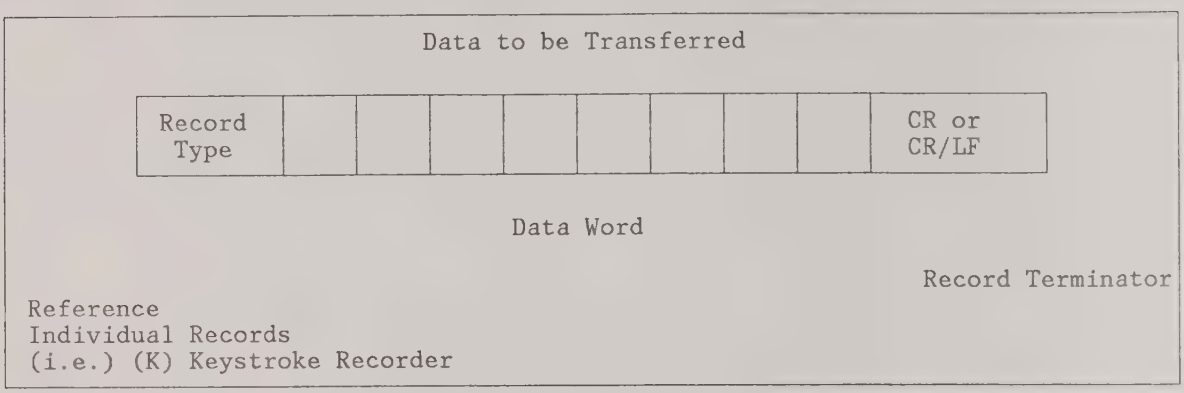

Figure 4-1 General Record Format

NOTE

When using the RS-232-C interface, the CR/LF terminator is always used.

Keystroke Record:

The first character of a Keystroke Record must be a 'K', the record type. The next characters are keystrokes. Each keystroke is represented by one or two ASCII characters as shown in Table 1.

This is an example of 'K' record:

"K / 6 0 / 75 & T 1"/ C R L F.

This keystroke record would cause the following to occur:

1. Set Cursor to 0.
2. Set reference to 5.
3. Timing Display.
4. Set the horizontal expansion factor to Hx3.

Reference Table 4-1.

In addition to the keys available on the K101-D/K102-D keyboard, a "pseudo" key has been provided to blank the CRT display; i.e., point zero (.0).

KEY DEFINITIONS

TABLE 4-1

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DESCRIPTION OF KEY	KEYCODE
0, Hx1	0
1, Hx3	1
2, Hx6	2
3, Hx12	3
4, Page down	4
5, V24	5
6,V12	6
7, V6	7
TTL, 8,Page up	8
ECL, 9, EBCDIC	9
A, ASCII	A
B, Binary	B
Sample, C	C
Glitch, D, Decimal	D
Latch, E, Octal	E
Demux, F, Hex	F
G	G
H	H
I	I
J	J
K	K
L	L
M	M
N	N
O	O
P	P
Q	Q
R	R
S	S
T	T
U	U
V	V
W	W
X	X
Y	Y
Z	Z
Don't Care, Asterisk	*
Plus, true	
Cursor Down	)
Cursor Left	<
Cursor Right	>
Cursor Up	(
Previous	#
Next	%
-Minus, False	-

KEY DEFINITIONS con't.

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DESCRIPTION OF KEY	KEYCODE
Data	$D
Timing	$T
Data Format	$F
Graph	$G
Polarity	$P
Trace	$S
Input	$I
Clock	$C
Stop	!0
Move A to B	!1
Move M to A	!2
Select A	!3
Select B	!4
Advance	!5
Compare	!6
Search	!7
Arm	!8
Period	&.
Less than	&<
Equal to	&=
Greater than	&>
Space	&;
Edit	/0
Insert	/1
Delete	/2
Save	/3
Recall	/4
Shift Recall	/5
Set Cursor	/6
Set Reference	/7
Shift Delete	/8
Blank CRT	.0

Memory Record:

The first character of a Memory Record must be an 'M', the record type. The next character selects which memory to change, 'A' or 'B'. The next group of three characters is the beginning sample index of the measurement data. The sample index field must be three ASCII digits, '0' through '9'. There are 515 samples of measurement data in each of A and B memory, referred to as '000' through '514'. The remainder of the record consists of memory data. For the K101-D, one sample is represented by thirteen ASCII encoded HEX characters with the first four representing group C, the next four group B, the next four group A. The last character represents the level at which the sample was recorded. For the K102-D, one sample is represented by nine ASCII encoded HEX characters with the first four representing group B, the next four group A and the last character representing the level at which the sample was recorded. The first character of each group represents channels F, E, D, and C.

This is an example of an 'M' record:

M A 020 0000FFFF0000F 0000FFFF00001 CR LF

NOTE
Commas should not be used.

Command Record:

The first character of a Command Record must be a 'C', the record type. The next characters are command codes. K101-D/K102-D commands fall into two groups. The first group of commands tell the K101-D/K102-D what type of record to send the next time it is addressed to talk. The second group causes the K101-D/K102-D program counter to jump to a specific RAM address or causes the K101-D/K102-D to begin a call at a given RAM address. If more than one command is given in a Command Record, only the last will be processed.

K101-D GPIB Command Codes:

CA Send the keystrokes for setting up the CLOCK SELECT.

CB Screen for the memory requested.

CM (K Record(s).)

CU Send a keystroke record for setting the cursor and reference for both memories A and B to their current values. (K Record.)

PS Send Print Records. (Record.)

FM Send the keystrokes for setting up the Data Format screen. (K Record.)

IA Send the keystrokes for setting up the INPUT screen for

IB the memory selected.

IM (K Record.)

IO Send data from specified I/O port xx. (I Record.)

This is an example of a 'C' record: "C M A, C R L F."

MB ...

MA Send the measurement data from the memory locations. Between and including the cursor and reference positions. If CURSOR>REFERENCE send data from cursor to end of memory for memory specified. (M Record(s).)

PA Send the keystrokes for setting up the LOGIC POLARITY

PB screen for the memory specified.

PM (K Record (s).)

SB ...

SA Send the keystrokes for setting up the TRACE SELECT screen for the memory specified.

SM (K Record(s).)

SR Send a Status Record. (S Record), and clear status byte; i.e., ASCII representation of the serial poll status byte plus a status indication.

TA Send data for the Acquisition time for the memory selected.

TB (T Record.)

VM Send DVM record (V Record); i.e., voltmeter reading.

ZM Send the keystrokes for setting up the INTERFACE screen. (K Record.)

Status Record:

The first character of a Status Record must be an 'S', the record type. The next group of eight characters represents the value of the GPIB Status Byte. The value of each bit of the GPIB Status Byte is encoded as an ASCII 0 or ASCII 1. The value of the MSB (bit 8) is given first, down through the LSB (bit 1). A comma starts the next field, the 'K101-D Recording Status' field. The recording status describes the current status of the K101-D/K102-D recording cycle. The first character in this field is the Recording Status Code, a number between '0' and '3'. This character is followed by a comma. The next four characters are the recording status message that is displayed in the lower right corner of the K101-D/K102-D display.

K101-D/K102-D RECORDING STATUS CODE

0	RDY
1	BUSY
2	CLK?
3	xxxx (Pass Count)

This is an example of an 'S' Record, shown with spaces for clarity:

S 0 1 0 1 0 0 0 0, 0 RDY CR

Display Record:

This record displays a string of characters, starting at a given location on the K101-D/K102-D screen. The position of the message is given as a row and column. There are 52 columns across the screen and 29 rows down the screen. However, the top-most and bottom-most rows (1 and 29 respectively) are not accessible to the GPIB.

The first character of a Display Record must be a 'D', the record type. The next four characters are the row and column positions. Two ASCII encoded decimal digits are used for the row, and two for the column. The range of row values is '2' through '28'; the range for column values is '1' through '52'. If the specified row is out of range, row position '2' is used. If the specified column is out range, column position '1' is used. The remaining characters constitute the message to be displayed. The row and column positions will be automatically

incremented until row '28', column '52' has been displayed. If there are still more characters to display, the remainder of the message will be printed starting at row '2', column '1'.

This is an example of a 'D' Record:
This is an example of a Display Record: D0322CR.

NOTE
Commas inserted between the row and column will cause errors with this command.

Print Record:

This record is used to output the current screen display. The K101-D/K102-D will send one record for each row of characters displayed on the screen. This record is provided so that a picture of the current K101-D/K102-D screen may be sent to a printer. This type of record will not be recognized by another K101-D/K102-D.

The first character of a Print Record is a ".", the record type. The next 52 characters are the ASCII characters displayed on one row of the K101-D/K102-D screen.

This is an example of a Print Record:
"." CLOCK=0020 nSEC GPIB=LOCS V=-00.00 17:42:13 MEM=M.

Port Record:

The first character of a Port Record is a 'P', the record type. The next two characters indicate the I/O port number from which the data was taken. These are in ASCII encoded HEX. The last four characters indicate the data read from the port, formatted as ASCII encoded HEX with the most significant digit being transmitted first.

This is an example of a Port Record: I, 01, 16BA, CR.

NOTE
To request a Port record: CIO XX.

Acquisition Time Record:

The first character of an Acquisition Time Record is a 'T', the record type. All characters in this record are ASCII. The next character indicates which memory the data represents, 'A' or 'B'. The next eight characters indicate the time at which the acquisition was taken (normally formatted HH:MM:SS). The next eight characters indicate the date (MM/DD/YY). The last ten characters indicate the trace time.

This is an example of an Acquisition Time Record: TA10:55:0105/20/8110 nanoseconds CR.

DVM Record:

The first character of DVM Record is a 'V', the record type. The next six characters are all ASCII and indicate the DVM reading.

This is an example of a DVM Record: V+20.48 CR.

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